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QUARTERLY RECORD OF PROGRESS IN ROPICAL AGRICULTURE AND INDUSTRIES ND THE COMMERCIAL UTILISATION OF HE NATURAL RESOURCES OF THE COLONIES AND INDIA

EDITED BY THE DIRECTOR AND PREPARED BY THE SCIENTIFIC AND TECHNICAL STAFF OF THE IMPERIAL INSTITUTE AND BY OTHER CONTRIBUTORS

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REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

The following summaries have been prepared from a selection of the Reports made by the Director of the Imperial Institute to the Colonial, Indian and other Governments concerned.

ECONOMIC PRODUCTS FROM THE ZANZIBAR PROTECTORATE

In a later section of this BULLETIN (p. 407) will be found an article by Mr. F. C. McClellan, Director of Agriculture in Zanzibar, dealing with the agricultural resources of that Protectorate. Specimens of most of the products referred to therein have been examined at the Imperial Institute, and an account of the results of examination of those received in recent years is given in the succeeding pages. The specimens of leguminous seeds, millets and oil seeds dealt with represent the ordinary produce as grown by the natives. Previous articles dealing with Zanzibar products will be found in the following numbers of this BULLETIN: mangrove barks and leather (1904, **2**, 163); *Telfairia pedata* seeds (1912, **10**, 223); cloves (1912, **10**, 572); clove-leaf oil (1913, **11**, 438.)

CLOVES

The seven samples which are the subject of this report were received in December 1913. They consisted of cloves, clove stems, and clove fruits ("mother of cloves"), and it was desired to ascertain the percentage of oil which they contained and their market value.

No. 1. "*Cloves from tree* 8 *to* 9 *years old. Loss in weight by drying* 67·3 *per cent.*"—These cloves were of deep brown colour and had an average length of $\frac{5}{8}$ in.

No. 2. "*Stems from No.* 1."—These consisted of the

stalks of the inflorescence from which the buds (cloves) had been removed.

No. 3. "*Cloves picked just before the buds turn pink, or about* 8–10 *days before ready. Tree about* 45 *years old.*"—These cloves were similar in colour and general appearance to sample No. 1; they were, however, somewhat shorter, the average length being $\frac{9}{16}$ in.

No. 4. "*Stems from No.* 3."—This sample consisted of the stalks of the inflorescence from which the buds had been removed.

No. 5. "*Cloves picked when the buds are pink and ready for picking. Tree about* 60 *years old.*"—These cloves were considerably paler in colour and of brighter and better appearance than samples 1 and 3.

No. 6. "*Cloves picked when in full flower. Tree about* 60 *years old.*"—These cloves were deep brown in colour and had an average length of $\frac{11}{16}$ in. The corollas were absent.

No. 7. "*Mother of cloves from tree about* 60 *years old.*"—This sample consisted principally of clove fruits, but a considerable number of buds were also present. The average length of the fruits was $\frac{18}{16}$ in. and the width from $\frac{3}{16}$ to $\frac{3}{8}$ in. The buds, which were without corollas, averaged $\frac{7}{8}$ in. in length.

The following table shows the percentage of oil yielded by each of these products, and the results of the examination of the oils at the Imperial Institute:

Sample.	Yield of oil.	Specific gravity of oil at $\frac{15°\,C.}{15°\,C.}$	Optical rotation of oil at 22° C.	Eugenol in the oil.
	Per cent.			*Per cent.*
1 (Cloves)	17·8	1·056	−0°23′	89
2 (Clove stems)	5·9	—[1]	—[1]	—[1]
3 (Cloves)	19·2	1·064	−0°30′	88
4 (Clove stems)	6·3	1·050	−0°42′	89
5 (Cloves)	18·8	1·049	−0°29′	84
6 (Cloves)	17·4	1·050	−0°37′	88
7 (Mother of cloves)	6·5	1·056	−0°33′	90

[1] *The sample was too small to admit of this determination.*

The yields of oil from the samples are quite satisfactory, ordinary cloves yielding on the average about 18 per cent. and clove stems about 6 per cent. of oil.

On comparing the odours of the clove oils with that of a high-grade, standard, commercial sample of clove oil, it was found that the odour of No. 3 very closely resembled that of the standard oil, whilst the odours of the other oils were inferior to it, gradually becoming less pleasant in the order 5, 1, 6. The oils from the mother of cloves (No. 7) and from the stems (Nos. 2 and 4) were also decidedly inferior in odour to the standard clove oil, though No. 4 was superior to No. 2; the oil derived from the mother of cloves (No. 7) was the least pleasant of the series.

It is interesting to note that the order of the clove oils for odour is the same as that for yield of oil from the samples, viz. 3, 5, 1, 6. The same remark applies to the two clove-stem oils, Nos. 4 and 2.

The samples were submitted to brokers, who classified and valued them as follows; the quotations are ex-wharf, London terms, less 2½ per cent. discount (March 1914):

No.	Grade.	Value per lb.
1.	fair cloves	6*d.*
2.	fair clove stems	2½*d.*
3.	good small cloves	7*d.*
4.	good stems	2½*d.*
5.	good picked cloves	8*d.*
6.	headless cloves	5*d.*
7.	mothers	2½*d.*

The brokers stated that all the samples were of good quality in their different classes and represented products which would be readily saleable in the London market.

It is impossible to draw any definite conclusions from the results of the examination of a single series of samples, but it is noteworthy that sample No. 3, consisting of cloves picked just before the buds turn pink, yielded the highest percentage of oil, which moreover possessed the best aroma. The comparison with No. 5, collected at the usual stage, may, however, possibly be vitiated by the fact that No. 3 was from a tree about 45 years old, whereas No. 5 was from a tree about 60 years old.

In order to ascertain definitely the effect of picking the cloves at different stages of development it is desirable that samples should be collected from trees of the same age and not from trees of different ages. The effect of the age of

the tree could be determined by collecting series of similar samples from trees of different ages.

MILLETS

The following five samples of the smaller-seeded cereals which are known collectively as millets were received in May 1912:

No. 1. "Uimbe" (*Eleusine coracana*, Gaertn.).—These seeds were in good condition and free from insect attack, and the sample was clean and practically free from extraneous matter. A small quantity of unhusked seeds was present.

These seeds gave the following results on analysis, compared with those obtained in the case of a sample of *E. coracana* seeds from Uganda (this BULLETIN, 1909, **7**, 151):

	Present sample. *Per cent.*	Sample from Uganda examined at the Imperial Institute. *Per cent.*
Moisture	10·3	14·0
Crude proteins	5·4	6·2
Consisting of:		
True proteins	5·2	—
Other nitrogenous substances	0·2	—
Fat	1·5	1·1
Starch, etc.	76·9	72·9
Fibre	3·4	3·0
Ash	2·5	2·8
Nutrient ratio[1]	1 : 14·9	1 : 12·2
Food units[2]	94	91·2

[1] *The ratio between the percentage of crude proteins and the sum of the percentages of starch and fat, the latter being first converted into its starch equivalent.*

[2] *The total obtained by adding the percentage of starch to* 2·5 *times the sum of the percentages of fat and crude proteins.*

The seeds contained no cyanogenetic glucosides.

The sample of *E. coracana* seeds from Uganda was valued as a feeding-stuff at £4 10*s.* to £5 per ton in London in 1908 (*loc. cit.*). The Zanzibar product should sell at about the same rates.

No. 2. "Umanga" (*Setaria* sp.).—These seeds were plump, clean, in good condition and free from extraneous matter, and showed no signs of insect attack.

The seeds were examined with the following results

compared with those afforded by a sample of *S. italica* seeds analysed at the Koloniaal Museum, Haarlem:

	Present sample.	*Setaria italica* seeds analysed at the Koloniaal Museum, Haarlem.
	Per cent.	*Per cent.*
Moisture	9·47	8·60
Crude proteins	10·20	11·81
Consisting of:		
True proteins	8·32	—
Other nitrogenous substances	1·88	—
Fat	4·31	3·12
Starch, etc.	65·11	61·44
Fibre	7·83	12·38
Ash	3·08	2·65
Nutrient ratio	1:7·3	1:5·8
Food units	101·4	98·8

The seeds contained no cyanogenetic glucosides.

The sample was submitted to a firm of brokers in Liverpool, who considered it of fair quality, and valued it at about 26*s.* per 480 lb., less 2 per cent. discount, c.i.f. Liverpool (February 1913).

No. 3. "Mawali" (*Pennisetum typhoideum*, Rich.).—This sample consisted of unhusked seeds, which were plump and in good condition, dry, practically free from extraneous matter, and showing no signs of insect attack.

The seeds were examined with the following results, compared with the analysis of *P. typhoideum* seeds recorded by Church in *Food Grains of India*:

	Present sample.	Recorded by Church in *Food Grains of India*.
	Per cent.	*Per cent.*
Moisture	10·60	11·3
Crude proteins	12·47	10·4
Consisting of:		
True proteins	11·37	—
Other nitrogenous substances	1·10	—
Fat	5·00	3·3
Starch, etc.	67·13	71·5
Fibre	2·80	1·5
Ash	2·00	2·0
Nutrient ratio	1:6·3	1:7·6
Food units	110·8	105·7

The seeds contained no cyanogenetic glucosides.

This grain does not come on the English market

regularly, but consignments would probably realise about 22*s.* per 480 lb. (May 1913).

No. 4. "Mtama Maupe. Sorghum white" (*Sorghum vulgare*, Pers.).—This consisted of rather small seeds, which, however, were plump and in good condition. They showed signs of slight insect attack, but the sample was otherwise clean and practically free from foreign grain and extraneous matter.

No. 5. "Mtama Maikundu. Sorghum red" (*S. vulgare*). —This consisted mainly of rather small seeds of poor appearance. It had suffered slightly from insect attack, and contained a small amount of dust.

The sample of red Sorghum (No. 5) was analysed, with the results given in the following table, compared with analyses of *S. vulgare* grain from other sources:

	Present sample of red Sorghum.	India "dari."	Sudan "dura."
	Per cent.	*Per cent.*	*Per cent.*
Moisture	10·0	10·70	8·45
Crude proteins	11·2	7·75	13·06
Consisting of:			
True proteins	10·8	—	—
Other nitrogenous substances	0·4	—	—
Fat	2·8	3·03	3·30
Starch, etc.	72·1	74·36	72·45
Fibre	1·8	2·21	1·03
Ash	2·1	1·95	1·71
Nutrient ratio	1 : 7	1 : 10·5	1 : 6·1
Food units	107	101·3	113·3

The seeds contained no cyanogenetic glucosides.

The following prices of Sorghum were quoted recently in Liverpool (July 1914):

Syrian dari, 33*s.*—35*s.* per 480 lb.

Indian dari, 30*s.*—30*s.* 3*d.* per 480 lb.

A small consignment of Sudan dura was sold in London in November 1912 at £6 per ton.

Information regarding this grain, its market value, and its utilisation is given in this BULLETIN (1911, **9**, 253; 1913, **11**, 33).

LEGUMINOUS SEEDS

The following products of this kind were received in May 1912:

No. 1. "Kunde" (*Vigna Catjang*, Walp., cowpea).—These varied in colour from mottled yellowish-brown to purplish-brown. A small proportion of the seeds was mouldy, and the sample had been attacked by weevils. The sound seeds were well developed and of good appearance.

There is a small market for these seeds in the United Kingdom. A sample received at the Imperial Institute from Hong Kong (see analysis on p. 344) was valued in London in 1911 at £8 per ton.

No. 2. "Chooko" (*Phaseolus Mungo*, Linn., green gram).—The sample contained a small percentage of discoloured, mouldy, and shrivelled seeds, and had been slightly attacked by insects; it also contained a small amount of foreign grain. The sound seeds were plump and of good appearance.

A sample of *P. Mungo* seeds (green) from Hong Kong, in good condition, was valued by merchants at £6 15*s.* per ton c.i.f. United Kingdom ports when "gram" was quoted at £6 13*s.* per ton in Liverpool (see this BULLETIN, 1912, **10**, 236). In May 1913 "gram" was quoted in Liverpool at £6 16*s.* per ton.

No. 3. "Fiwi" (*Dolichos Lablab*, Linn.).—These beans varied in colour from yellowish-brown to purplish-brown. They were plump and on the whole in good condition, but about 8 per cent. had been attacked by insects, causing a slight amount of damage. A small amount of foreign grain was present.

A sample of *D. Lablab* beans from Hong Kong was submitted by the Imperial Institute in 1911 to brokers, who reported unfavourably on them, and stated that they would not readily find a market in London except at a low price (*loc. cit.*, p. 236).

No. 4 "Mbaazi" (*Cajanus indicus*, Spreng., white).—These beans were plump and well developed. About 25 per cent. showed signs of insect attack, but otherwise the sample was clean and practically free from extraneous matter.

No. 5. "Mbaazi" (*C. indicus*, black).—These beans resembled those of sample No. 4, but were a little smaller. About half of the sample had been attacked by insects, and a small percentage of foreign grain was present.

The seeds of *C. indicus* are known on the English market as "pigeon peas." A sample from Sierra Leone was valued in June 1910 at from £4 to £5 per ton in London for feeding purposes (this BULLETIN, 1910, **8**, 405). A sample from the Sudan was valued at from £5 10s. to £6 10s. per ton in September 1912, the higher price being due to a general rise in prices in the interval.

All the above samples represent well-known products, and they were therefore not analysed at the Imperial Institute. The following figures already recorded for samples of the same seeds from various countries may, however, be quoted for reference:

(1) *Vigna Catjang*

	From Hong Kong.	From the Sudan.	From India.
	Per cent.	*Per cent.*	*Per cent.*
Moisture	11·65	7·95	12·7
Crude proteins	22·05	20·61	23·1
Fat	1·23	1·63	1·1
Starch, etc.	57·99	64·07	55·3
Fibre	3·83	2·76	4·2
Ash	3·25	2·98	3·6
Nutrient ratio	1 : 2·7	1 : 3·3	1 : 2·5
Food units	116·2	119·7	115·8

(2) *Phaseolus Mungo*

	From the Sudan.	From India.
	Per cent.	*Per cent.*
Moisture	8·02	10·1
Crude proteins	27·00	22·7
Fat	1·20	2·2
Starch, etc.	56·31	55·8
Fibre	3·83	4·8
Ash	3·64	4·4
Nutrient ratio	1 : 2·19	1 : 2·7
Food units	126·8	118·0

(3) *Dolichos Lablab*

	From Hong Kong.	From the Sudan.
	Per cent.	*Per cent.*
Moisture	12·63	7·40
Crude proteins	19·51	23·53
Fat	1·24	1·05
Starch, etc.	57·66	56·28
Fibre	5·89	7·95
Ash	3·07	3·79
Nutrient ratio	1 : 3·1	1 : 2·5
Food units	109·5	127·7

(4) and (5) *Cajanus indicus*

	From the Sudan.	From Sierra Leone.
	Per cent.	*Per cent.*
Moisture	7·49	9·1
Crude proteins	20·11	18·1
Fat	1·66	1·0
Starch, etc.	60·58	61·8
Fibre	6·21	6·4
Ash	3·95	3·6
Nutrient ratio	1 : 3·2	1 : 3·5
Food units	115·0	109·5

No. 6. "Njugu Mawe" (*Voandzeia subterranea*, Thou.).—The sample consisted mainly of yellow beans, but a few purple, brown, and black beans were present. The beans were plump, but about 70 per cent. had been attacked by insects, although in the majority of cases the damage was not extensive. The sample contained a few broken beans and foreign grains.

These beans were analysed with the following results, compared with those of the examination at the Imperial Institute of a previous sample from Northern Nigeria (this BULLETIN, 1909, **7**, 151):

	Present sample.	Previous sample from Northern Nigeria examined at the Imperial Institute.
	Per cent.	*Per cent.*
Moisture	7·8	13·1
Crude proteins	19·1	16·0
Consisting of:		
True proteins	18·0	—
Other nitrogenous substances	1·1	—
Fat	6·5	6·2
Starch, etc.	58·9	58·4
Fibre	4·2	3·9
Ash	3·5	2·4
Nutrient ratio	1 : 3·9	1 : 4·5
Food units	123·0	113·9

The seeds contained no cyanogenetic glucosides.

The sample from Northern Nigeria previously examined at the Imperial Institute was submitted to a firm of manufacturers of feeding-cakes, who stated that they could not find that the seeds had ever been used in the United Kingdom (*loc. cit.*) and did not consider that they would have a very high commercial value as a feeding-stuff for cattle. The

seeds are, however, a useful foodstuff, and their cultivation for local use might be encouraged in districts where more valuable leguminous crops, such as the true ground nut and the soy bean, cannot be remuneratively grown.

Oil-Seeds

Para Rubber Seed

A sample of Para rubber seeds was received in April 1913. They had the ordinary appearance of the seeds of *Hevea brasiliensis*, but were larger than is usually the case. They consisted of husk 56 per cent. and kernel 44 per cent.

The kernels contained 7·1 per cent. of moisture, and, on extraction, furnished 45 per cent. of oil, which is about the usual yield for the kernels of Para rubber seed. The oil was clear, golden yellow in colour, and deposited a little "stearin" on standing. It was examined with the following results compared with those previously recorded at the Imperial Institute:

		Present sample.	Results previously recorded at the Imperial Institute.
Acid value		42·7	10·7 to 29·9
Saponification value		198·8	185·6 „ 195·7
Iodine value	*per cent.*	136·0	121·2 „ 136·2

The oil was rather acid, but otherwise had the usual characters of Para rubber seed oil.

Para rubber seed should be decorticated in the country of origin and the kernels alone shipped to Europe. If carefully dried in the sun and shipped in bags these Zanzibar kernels would probably realise about £10 per ton in the United Kingdom (August 1913).

Further information regarding the value and commercial utilisation of Para rubber seed kernels is given in this Bulletin (1903, **1**, 156; 1904, **2**, 22; 1909, **7**, 95; 1911, **9**, 35; 1913, **11**, 551).

Sesamum Seed

Two samples of sesamum seed were received in May 1912.

No. 1. *White Sesamum.*—This consisted of small, plump seeds, of dark cream colour and of somewhat dirty appearance. The sample was slightly dusty.

The seeds yielded 53·8 per cent. of oil, which had the usual appearance of sesamum oil.

No. 2. Black Sesamum.—These were small, very dark brown seeds, many of which were rather flat, while some were quite immature. The sample was rather dusty.

The seeds yielded 49·1 per cent. of oil, which had the usual appearance of sesamum oil.

The present price of sesamum seed in the United Kingdom is from 56*s.* to 60*s.* per quarter (384 lb.), and in Marseilles 42·50 to 57 francs per 100 kilos (June 1914). The black seed is somewhat less valuable than the white.

An account of the cultivation, production, and utilisation of sesamum seed appeared in this BULLETIN (1911, **9**, 259).

Kapok Seed

This sample, which was received in April 1913, consisted of small brownish-black seeds, with the usual appearance of *Eriodendron anfractuosum* seeds.

The seeds contained 12·7 per cent. of moisture, and on extraction furnished 21 per cent. of oil, which is a normal yield. The oil was clear, brownish-yellow in colour, and possessed a faint smell.

It was examined with the following results:

Specific gravity at $\frac{15{\cdot}5^\circ\ \text{C.}}{15{\cdot}5^\circ\ \text{C.}}$	0·914
Acid value	26·0
Saponification value	194·2
Iodine value . . . . . *per cent.*	101·5

The seed represented by this sample should be saleable in Europe at the current price if marketed in commercial quantities. Kapok seed in Java was worth at the time of the report £4 10*s.* to £4 16*s.* per ton, and its value in Rotterdam, which is the principal European market for this product, was about £6 10*s.* per ton (August 1913).

Jatropha Curcas Seed

A sample of "mbono" seed (*Jatropha Curcas*, Linn.) was received in May 1912.

The seed was in good condition, and had the usual

appearance of *J. Curcas* seed; a few broken seeds and kernels without shells were present. The seeds consisted of shell 33·7 per cent. and kernel 66·3 per cent. The latter yielded 51·2 per cent. of oil, equivalent to a yield of 33·9 per cent. from the entire seeds.

A market could no doubt be found for this seed, but so far it has not been produced in quantities large enough to warrant large-scale trials being made with it in the United Kingdom. An account of the seed and of the oil which it yields was given in this BULLETIN (1904, **2**, 170).

Ground Nuts

A sample of "njugu Nyassa" nuts (*Arachis hypogaea*, Linn.) was also received in May 1912.

The nuts were medium-sized and in very poor condition, the shells being covered with a thin coating of earthy matter, whilst a large proportion of the kernels were mouldy. The nuts consisted of shell 28 per cent. and kernel 72 per cent. The latter yielded 52·0 per cent. of oil, which is a normal yield (see this BULLETIN, 1910, 8, 153). The oil had the usual appearance of ground-nut oil.

Ground nuts in the condition of this sample from Zanzibar would probably not be readily saleable in Europe at good prices, but nuts with clean shells and well-dried kernels free from mould would find a ready market for edible purposes.

Moringa pterygosperma Seeds

A sample of "mronge" seed (*Moringa pterygosperma*, Gaertn.), was received at the same time as the preceding sample.

The seeds were pale brown and round, with three papery "wings." The seed consisted of shell 39 per cent. and kernel 61 per cent. Some of the kernels were mouldy. The yield of oil from the kernels was 28·6 per cent. The oil had the usual character of *M. pterygosperma* oil.

The yield of oil from the kernels of these seeds is somewhat low, as a previous sample from Northern Nigeria examined at the Imperial Institute contained 38 per cent.

of oil in the kernels. The low yield in the present case may perhaps be due to the presence of mouldy kernels.

The results of the examination at the Imperial Institute of previous samples of Moringa seed and Moringa-seed oil were given in this BULLETIN (1904, **2**, 117). Further samples of the seed and oil have also been examined by commercial and technical experts. From these investigations it appears that the seed would be saleable in Europe if obtainable in quantity, but that its value is at present rather doubtful owing to the fact that it is uncertain whether the residual cake can be used as a feeding-stuff. If this were the case the seeds would probably realise from £7 to £8 per ton in the United Kingdom. The cake, however, has been found to contain traces of an alkaloid, and also a large quantity of non-albuminoid nitrogenous matter, and it may consequently be found unsuitable for use as a feeding-stuff.

The oil could be used for soap-making, and for this purpose would probably have a somewhat lower value than cotton-seed oil, which is at present worth from 32*s.* to 34*s.* per cwt. in Liverpool (June 1914). At one time the oil was used to some extent for lubricating delicate machinery, such as clocks, etc., but recent trials have shown that it is not particularly suited for this purpose, for which it is now superseded by sperm oil.

Castor Seed

A sample of castor seed ("mbarika") was received at the same time as the preceding sample. It consisted of small, dark, greyish-brown, mottled seed in good condition.

The present price of Bombay castor seed in the United Kingdom is £10 17*s.* 6*d.* per ton (June 1914), and this Zanzibar seed would probably fetch about the same price if exported in good condition.

Oil-Palm Nuts

A sample of oil-palm nuts, known locally as "mchikichi," was received in May 1912. The nuts were rather small, with shells of medium thickness. They consisted of shell 61 per cent. and kernel 39 per cent.

The kernels furnished 52·7 per cent. of oil, representing a normal yield (see this BULLETIN, 1909, **7**, 390; 1913, **11**, 206). This product had the usual appearance of palm-kernel oil.

Undecorticated palm nuts such as those in the present sample would be unsaleable in Europe, but the dried kernels freed from the shells would realise the ordinary market price of palm kernels, the current value of which is £18 to £19 2*s.* 6*d.* per ton, less 5 per cent. ex quay Liverpool (June 1914).

SEED OF *CAESALPINIA BONDUCELLA*, FLEMING

The seed which is the subject of this report was received in May 1912.

The sample consisted of more or less spherical seeds, about ¾ in. in diameter, and varying in colour from pale grey to slate grey; a few brown seeds were also present. The shell was hard, and enclosed a nearly white starchy kernel which was intensely bitter.

These seeds are the "Haba de San Antonio" of the Mexican Pharmacopœia. They are stated to be used in Mexico as a tonic and antiperiodic, their activity being ascribed to the presence of an ill-defined bitter principle known as "bonducin" or "guilandinin," which, when administered in doses of 10 to 20 centigrams, is alleged to be as effective as quinine. The kernels have also been stated to contain an alkaloid and about 20 per cent. of a fatty oil.

There is no demand for this seed in Europe.

COIR ROPE AND MATTING

Samples of coir rope and matting, made in the Zanzibar prisons, were received for examination in July 1912.

The samples were submitted to a large firm of matting and rope importers, who reported that the rope was very well made, being level spun, regular and of good colour, and that they were of opinion that there would be a good market in the United Kingdom for such rope. They stated that the principal sizes of coir rope used in the United Kingdom are from 1½ in. to 3 in. in circumference, and that for this market the rope should be put up in coils of 60 fathoms,

with a small piece of gunny attached to the coil and bearing the shipping mark.

The firm pointed out that this rope from Zanzibar is only three-strand, whereas the coir rope shipped from Cochin is always four-strand.

With reference to the matting, the firm reported that the usual widths imported into the United Kingdom are 18 in., 19 in., 36 in., 45 in., 54 in., and 72 in., and that the material is put up in pieces of 25 and 50 yards.

A trial consignment of coir rope and matting was received for sale in London in May 1914. The former was sold at the rate of 20*s.* per cwt., and the matting at 8*d.* per square yard. The prices which these materials realise in Zanzibar are 15*s.* per cwt. and 1*s.* 4*d.* per square yard respectively.

Seaweed

The seaweed which is the subject of this report was received in February 1913. The weed was stated to occur plentifully on the north of Zanzibar Island, and it was desired to ascertain its value as a manure for coconuts.

The sample consisted of dry, papery fronds, about half an inch wide. Most of the fronds bore a surface incrustation of calcium carbonate.

The weed as received at the Imperial Institute was found to contain:

		Per cent.
Moisture	H_2O	20·72
Nitrogen	N	0·76
Ash (containing much sand)		30·26

The ash was submitted to partial analysis with the following results:

		Expressed on the ash.	Expressed on the original weed.
		Per cent.	*Per cent.*
Lime	CaO	15·86	4·79
Magnesia	MgO	7·84	2·37
Potash	K_2O	1·82	0·55
Soda	Na_2O	14·31	4·33
Sulphuric acid	SO_3	6·49	1·96
Phosphoric acid	P_2O_5	0·36	0·11
Chlorine	Cl	15·93[1]	4·82

[1] *Equivalent to 26·3 per cent. of sodium chloride.*

These results show that this seaweed from Zanzibar contains much lower percentages of nitrogen, potash, and phosphoric acid than certain seaweeds belonging to the genera Fucus and Laminaria. The weed would be useful as a manure for soils on which coconuts are grown, but the proportion of potash is low, and as this constituent is of considerable importance to coconuts it would be necessary to apply to the soil, in addition, some form of manure rich in potash.

WHEAT FROM THE SUDAN

WHEAT growing in the Sudan has increased steadily during recent years, but the area devoted to this crop is still very small in comparison with that devoted to dura (*Sorghum vulgare*), the staple foodstuff of the country, as is shown in the following table:

	1910.	1911.	1912.
	Feddans.	*Feddans.*	*Feddans.*
Wheat	19,681	26,972	29,193
Dura	1,192,883	835,126	1,187,038

1 *feddan* = 1·038 *acre.*

The wheat is grown almost entirely under irrigation, either artificial or flood; it was grown as a rain crop on only 176 feddans in 1910, on twenty feddans in 1912, and there was none at all grown in this way in 1911. At present wheat is cultivated chiefly in the Dongola and Berber Provinces, and it is thought that its cultivation may increase somewhat on the riverain estates of these Provinces, as well as on those of Khartoum and Halfa Provinces, and that it will certainly do so to some extent in the basin area of Dongola as the irrigation schemes become perfected. Good crops can be grown in the Gezira, south of Khartoum, where an extensive irrigation scheme is in progress.

At the present time the production of wheat in the Sudan does not meet the local demands, and considerable

quantities of wheat and flour are imported, the statistics for recent years being as follows :

	1911.		1912.		1913.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	lb.	£	*lb.*	£	*lb.*	£
Wheat . .	1,058,639	4,471	5,729,369	23,608	3,807,218	16,062
Flour (wheat) .	16,552,104	79,010	17,420,328	88,412	18,230,983	89,983

Experimental work with wheat is being carried on at a number of the experimental and demonstration stations which are under the control of the local Department of Agriculture, and three samples of wheat grown under irrigation at the Gezira Agricultural Experimental Station at Tayiba were received for examination at the Imperial Institute in July 1913.

The samples were as follows :

No. 1. "*Egyptian Wheat.*"—This sample contained a small proportion of earth and grit. The grains of wheat were in good condition, and fairly large and plump; some were translucent and others white and opaque. The flour yielded by this wheat had a slight but distinct yellow tint.

No. 2. "*Dongola Wheat.*"—This sample contained a quantity of earth and grit, but it was otherwise in good condition. The grains were of medium size, and were semi-translucent. The wheat gave a flour of a rather dirty white appearance.

No. 3. "*Indian Wheat.*"—This sample also contained a little earth. The grains were of medium size and in good condition; some were white and opaque, and others were semi-translucent. The wheat yielded a flour with a yellowish tinge.

The samples were submitted to chemical examination with the following results :

	1. "Egyptian." *Per cent.*	2. "Dongola." *Per cent.*	3. "Indian." *Per cent.*
Moisture	10·6	9·7	10·2
Total protein	10·5	11·8	8·7
Gluten	9·0	11·9	7·0
Gliadin	3·8	4·9	3·1

The three wheats were submitted for milling and baking trials to Mr. A. E. Humphries, who reported that all the samples were very dirty and contained an unreasonably large percentage of grit. The three lots were cleaned, conditioned, and milled, and baking trials were subsequently made. As a result of these tests it was found that the samples behaved on the whole in a similar manner to average Indian wheats as now met with in commerce. The "Dongola" wheat was the least attractive in appearance, and consisted of a mixture of naturally mellow and naturally hard wheats. The latter fact is a great disadvantage from the miller's point of view, as hard wheats require to be conditioned quite differently from naturally mellow wheats, and if the two are mixed together before that stage in milling has been reached it is impossible to obtain the best results. It was found, however, that in spite of its mixed character and the presence of much dirt, the sample of "Dongola" wheat yielded the best flour of the three.

Samples 1 and 3 were very similar, but the expert preferred No. 1 ("Egyptian"), which he stated nearly resembled in baking quality ordinary Choice White Kurrachee wheat.

The expert pointed out that each of the three samples appeared to consist of more than one variety of wheat, and although the separation of the different varieties was more particularly desirable in the case of the "Dongola" sample, the other two wheats would also require some sorting out. He suggested that in further cultivation experiments each variety thus separated should be grown as a distinct type of wheat, with a view to ascertaining which is the best.

It was pointed out in the report that it is very desirable, if Sudan wheats are to be exported to the United Kingdom, that they should be shipped in a much cleaner condition than the present samples. Indian wheats are now sold in the United Kingdom on "clean terms," and since these terms have been instituted the relative value of Indian wheat has appreciated considerably.

PEAS AND BEANS FROM BURMA

THE *Phaseolus lunatus* beans at present shipped from Burma to this country and the Continent are of two kinds, known respectively as "red" and "white" Rangoon beans. The former yield minute and usually harmless amounts of prussic acid when ground into meal and mixed with water, and the "white" beans generally yield none or mere traces of prussic acid under like conditions (see this BULLETIN, 1912, **10**, 654). Although, so far as is known, no harm has arisen from the use of the red beans they are regarded with some suspicion by agricultural experts in Europe, and they realise comparatively small prices in the markets. In 1912 the red Rangoon beans realised only about £6 per ton in this country and in Europe, whilst white Madagascar beans, which are used for human food, were fetching over £24 per ton. In view of these facts the Imperial Institute in consultation with merchants in London suggested to the Department of Agriculture in Burma that steps should be taken to encourage the natives to cultivate a better class of beans for export, and a sample of white Madagascar beans of the kind in demand in this country was forwarded to the Department for trial cultivation. The merchants who were consulted also pointed out that the peas at present grown in Burma are practically valueless on the London market, and they suggested that experiments should be made in the cultivation of "Victoria" peas and "Green" peas. Samples of these were also therefore forwarded by the Imperial Institute to Burma for trial. The results of these trials are given in the *Report of the Mandalay Agricultural Station, Burma, for the year* 1912-13.

The experiments were carried out at the Natywagon Experimental Area on a fine, easily worked, sandy loam which had previously been used for the cultivation of indigenous beans and which was typical of the soils selected for the cultivation of these crops by Burmans in the riverine tracts of the country.

The Madagascar beans were sown on low ridges, and,

the season being late and exceptionally dry, the plants had to be watered once a week until they were a foot high. Although 9 lb. of seeds (numbering about 3,000) were sown, only 350 plants reached maturity, and these yielded a total crop of 41¼ lb. of seed. The plants branched freely and exhibited a habit similar to that of the red Rangoon bean ("pe-gya"), but were almost twice as large. Like pe-gya the Madagascar beans proved to be continuous bearers which necessitated the pods being gathered as they ripened, at intervals varying with the dryness of the season; this disadvantage they exhibited to a greater degree than pe-gya.

The Victoria peas did better than the Green peas, but revealed no feature of special value over the Burmese "sadaw-pe" which is already commonly grown. From 2 lb. of Victoria peas sown, 12 lb. of seed were reaped. The Green peas were attacked by a pod-borer which destroyed the greater part of the crop, and only 2 lb. of seed were reaped from the 2 lb. of seed sown.

Experiments were also made at Natywagon with a view to selecting an indigenous variety of Rangoon bean which would give a low yield of prussic acid, and at the same time would be suitable for cultivation in Burma. The types used in these experiments were selected from the pe-gyas received from Madaya (Mandalay District), Kyauksé, Mônywa, Katha, Tharrawaddy, and Falam (Chin Hills), and consisted of beans which varied in colour from a pale buff through mottled purple to deep red and even black. The seeds of all the beans which were reaped were lighter in colour than the seeds sown. The only variety of white Rangoon bean ("pe-byu-gale") experimented with was obtained from the Mandalay District. In this case, the reaped seeds had an appearance identical with that of the seed sown.

Specimens of the Madagascar beans, Victoria peas, and of certain of the indigenous beans produced in the course of these experiments were received at the Imperial Institute for examination in May 1913. The descriptions supplied by the Deputy Director of Agriculture, Northern Circle, Burma, were as follows:

Number of sample.	Name.	Description of seed from which sample was grown.	Origin of seed.	Remarks.
1	Pe-byu-gyi (Madagascar bean)	Ordinary seed without selection	Imperial Institute	Yield per acre 820 lb. only. The seed was received too late for a proper test of yield to be made. Prospects good.
2	Sadaw-pe (Victoria pea)	ditto	ditto	Yield very poor. Sown too late. Prospects not good.
3	Pe-byu-gale (Rangoon white bean)	The common white *Phaseolus lunatus* of Burma	Low country	This is the same throughout the country. Only grown in the plains.
4	Pe-gya (red bean)	Seed of a light colour only	ditto	ditto
5	ditto	Seed of a dark colour only	ditto	ditto
6	ditto	Mixed seed as received from the districts	ditto	ditto
7	Tim Sin	Seed of a black colour	Chin Hills	Grown on the Chin and adjacent hills only.
8	Kawl-be	Seed of a red colour only	ditto	ditto
9	ditto	Seed of a light colour	ditto	ditto
10	ditto	Mixed seed as ordinarily cultivated by the Chins	ditto	ditto

The results of the examination of the samples at the Imperial Institute are given below:

No. 1. *Madagascar beans* (*pe-byu-gyi*).—Large, white, kidney-shaped beans, from 0·7 to 0·9 in. long, plump and of good appearance.

No. 2. *Victoria peas* (*sadaw-pe*).—Small, rounded, creamy-brown peas, $\frac{1}{4}$ in. in diameter, plump, and of good appearance.

No. 3. *Pe-byu-gale.*—Small white beans similar to the white Burma or Rangoon beans of commerce.

No. 4. *Pe-gya* (*light*).—Beans of pinkish-cream to pinkish-brown colour; a few were marked with very slight purplish-pink specks.

No. 5. *Pe-gya* (*dark*).—Purplish-pink beans with pale brown specks or patches.

No. 6. *Pe-gya* (*ordinary*).—Coloured beans which could be separated into three groups: (1) pinkish-cream to pinkish-brown; (2) same as (1) but with purplish-pink specks or patches; and (3) purplish-pink with light specks or patches.

No. 7. Tim Sin (*black*).—Beans of uniform black colour, except at the hilum, which was nearly white.

No. 8. *Kawl-be* (*red*).—Beans of uniform dark purple colour.

No. 9. *Kawl-be* (*light*).—These beans were on the whole very similar in appearance to No. 4 (pe-gya light).

No. 10. *Kawl-be* (*ordinary*).—Beans showing all the colours of samples 7, 8, and 9, and bearing specks and patches. Only a few were of uniform purple colour.

The beans of samples 3 to 10 were similar in shape and size; they were of rounded oblong shape, tapering at one end, and measuring approximately 0·4 in. in length. They were plump and of good appearance. The hilum was in all cases nearly white.

All the samples were clean, in good condition, and practically free from insect attack.

The samples were submitted to chemical examination, and the percentage of prussic acid which they yielded, expressed on the peas and beans as received, is shown in the following table:

No.	Variety.	Yield of prussic acid. *Per cent.*
1.	Madagascar beans	0·005
2.	Victoria peas	nil
3.	Pe-byu-gale	0·03
4.	Pe-gya (light)	0·015
5.	„ (dark)	0·01
6.	„ (ordinary)	0·04
7.	Tim Sin (black)	0·03
8.	Kawl-be (red)	0·05
9.	„ (light)	0·055
10.	„ (ordinary)	0·04

The Madagascar beans and Victoria peas were submitted to the firm of merchants in London who originally supplied the seed from which they were grown. The firm reported on the samples as follows:

(1) The Madagascar beans are of good quality, though some of them have a slight yellow tinge; if the standard of this sample were maintained the beans should realise the ordinary price of Madagascar beans. The "spot" price of the latter in London at the date of report

(September 1913) was 23*s.* per cwt., and that for "forward shipment" 18*s.* per cwt.

(2) The Victoria peas are also of good quality, but rather smaller than the seed from which they were grown. The value of the sample was £8 to £10 per ton in London (September 1913).

No valuations of the other beans (samples 3 to 10) were obtained, as they are at present only of interest in connection with the selection experiments which are in progress in Burma.

The merchants who examined the samples of Madagascar beans and Victoria peas included in this series appeared to be satisfied with the quality of these products, and it will be interesting to see whether the standard will be maintained in the future. The Madagascar beans of commerce yield as a rule very little prussic acid or none at all. The sample of Madagascar beans sent from the Imperial Institute, and from which this present sample was grown, gave 0·0025 per cent. of prussic acid; and the sample grown in Burma yielded, as shown above, just twice as much. Even this amount, however, is only half that present in the best sample of Burma beans described above (Pe-gya No. 5), which yielded 0·01 per cent. of prussic acid. It will be of interest to note how the future samples of Madagascar beans grown in Burma will behave in this respect.

The beans produced by selection experiments with Rangoon beans have afforded interesting results. The white Rangoon beans yielded 0·03 per cent. of prussic acid, which is high for the variety, though not higher than has been recorded for this kind in recent years. As regards the coloured Rangoon beans, it is noticeable that sample No. 6, consisting of ordinary mixed pe-gya beans, yielded more prussic acid than the two samples of uniformly coloured beans (Nos. 4 and 5) obtained by selection. No general conclusions can, however, be drawn from this, since the reverse is the case with the samples of "ordinary mixed" (No. 10), and "selected uniform" (Nos. 8 and 9) kawl-be beans.

It was pointed out in the report on these samples that

it is very desirable that the experiments should be continued, with a view to the isolation of pure races of these beans, and that when this has been done further experiments should be carried out in order to ascertain the effect of locality, soil, and seasonal variations in climate on the cyanogenetic behaviour of the races.

At the request of the Department of Agriculture in Burma, two tons of Madagascar beans have been forwarded for experimental cultivation by sundry co-operative societies in the Province. By this means the beans will be tested on an extended scale, and their value for general cultivation throughout the country should thus be definitely ascertained.

TIMBERS FROM VARIOUS COUNTRIES

In the following pages an account is given of the results of examination of several timbers from parts of Africa and from British Guiana, which have been received recently at the Imperial Institute.

Teak from Nigeria

Plantations of teak (*Tectona grandis*, Linn.) have been made in a number of the forest reserves in the Southern Provinces, Nigeria. So far the results have been very promising, and the trees have grown well, but none of them are at present old enough to supply large timber. Samples of the wood obtained from a specimen tree, twenty-six years old, grown at the Ebute Metta Gardens, were forwarded to the Imperial Institute in May 1912 in order that its mechanical properties and working qualities might be determined. The tree was not growing under very favourable conditions, as the soil was impregnated with salt and was exposed at spring tides to the influence of salt water. Three pieces of the timber, marked A, B, and C, were supplied, and these were examined with the results given in the following pages.

Working Qualities

The wood was fairly well seasoned, and specimen pieces showed little sign of warpage or shrinkage after cutting.

In colour, texture, and markings the wood is very like East Indian teak and would be difficult to distinguish from the latter. It also works similarly to East Indian teak with all machine and hand tools, being hard, moderately tough, and strongly bound together by numerous fine medullary rays. It unites excellently with glue, and takes a good polish which brings out the colour well.

Some portions of the wood contained rather frequent knots and the grain was generally irregular in consequence, but other pieces were freer from knots and worked cleaner.

If the timber could be supplied in bulk similar to the latter pieces, it could be used for any purpose for which East Indian teak is employed.

Mechanical Properties

The mechanical properties of the timber have been determined for the Imperial Institute by Prof. W. E. Dalby, F.R.S., of the City and Guilds (Engineering) College, who has furnished the following report:

Description of the Wood.—The wood was received in the form of three logs, from which the following test pieces were cut:

(1) 10 beams 3·75 in. × 3·75 in. section and 42 in. long.

(2) 20 blocks 3·75 in. × 3·75 in. section and 6 in. long.

(3) 6 pieces for shearing tests (see p. 364).

The 10 beams were tested in bending with a single load in the centre.

The 20 blocks were tested to failure in compression.

The remaining pieces were tested in shearing until they failed.

The wood is of greenish-yellow colour, not unlike Burma teak, but it has not the same characteristic smell; it is a much drier wood and there appears to be no oil in the fibres. It is fairly free from knots, wanes, and shakes, etc., and judging from looks only would appear to be quite excellent wood; on test, however, it does not come out so well. The density appears to be somewhat lower than that of ordinary teak (Indian), being 45 lb. per cubic foot

average, while Indian teak appears to average about 49 lb. per cubic foot. The strength also appears to be rather below that of the Indian teak.

The average percentage of volatile matter, driven off on heating the wood at 105° C. was 11·2, calculated on the original weight of the wood.

Bending Tests to Destruction.—These tests were carried out on a small 10-ton screw-loaded Buckton testing machine, arranged so that a measured central load could be applied on a span of 36 in., which was kept constant in all cases.

The beams were measured and then placed singly in the machine. A telescope was arranged to focus on a scale affixed to the beam; then loads increasing by 500 lb. at a time were applied and the scale-reading noted, this being continued until fracture took place.

Plotting the scale-reading against the corresponding load gives a curve which is initially straight but departs from the straight line above certain values, and the value at which the curve falls away from the straight is taken to be the elastic limit of the beam.

From the deflection at the elastic limit the modulus of elasticity can be calculated.

The modulus of rupture (coefficient of transverse strength) is obtained from the breaking load.

Thus we have:

(*a*) Modulus of elasticity $= E = \frac{WL^3}{4BH^3\delta}$ lb. per sq. in.

where W = elastic limit (lb.); L = span (inches); B = breadth; H = height; δ = deflection (inches).

(*b*) Modulus of rupture $= \frac{3W'L}{2BH^2}$ lb. per sq. in., where W′ = the breaking load in lb.

Table I. (p. 363) gives the results of the bending tests.

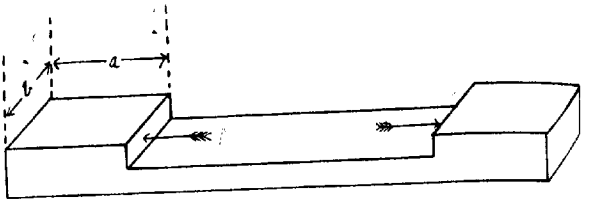
Compression Tests.—The blocks were tested and crushed to destruction in a 100-ton Buckton testing machine arranged for compression. In all cases the appearance of the block before testing was noted, and also the breaking load. All blocks were carefully measured before testing.

TABLE I. BENDING TESTS.

Test piece cut from	Breadth. *Inches.*	Depth. *Inches.*	Span. *Inches.*	Density. *lb. per cub. ft.*	Modulus of rupture. *lb. per sq. in.*	Elastic load up to *lb.*	Stress at elastic limit. *lb. per sq. in.*	Modulus of elasticity. *lb. per sq. in.*	Remarks.
Log A	3·79	3·94	36	45·1	9,200	6,900	6,900	1,160,000	Very knotty piece; mostly heart wood; pith along one side.
Log B	3·77	3·77	36	45·4	11,370	7,250	7,340	1,295,000	Very knotty specimen; sap and heart wood.
do.	3·77	3·75	36	43·6	11,720	6,500	6,650	1,500,000	Cracked initially; mostly heart wood; pith along one side.
do.	3·77	3·77	36	43·5	12,050	8,500	8,570	1,290,000	Sound before test; heart and sap wood.
do.	3·78	3·77	36	43·8	7,550	3,000	3,020	960,000	Bad knot at centre; unsound in middle; heart wood; pith along one edge.
do.	3·76	3·78	36	45·0	12,000	9,000	9,014	1,287,000	Very dry wood; beam sound before test; brittle fracture.
do.	3·75	3·78	36	45·4	11,370	7,250	7,340	1,295,000	Sound before test; heart and sap wood; white marks along grain.
Log C	3·76	3·75	36	42·3	4,600	—	—	1,030,000	Cracked before testing; knotty.
do.	3·76	3·78	36	43·5	10,050	6,050	6,050	1,400,000	Sound before test; partly sapwood; white marks along grain.
do.	3·77	3·77	36	43·8	12,050	8,050	8,050	1,450,000	Sound before test; small knots; mostly heart wood.

Table II. (p. 365) gives the results of the tests.

Shearing Tests.—The test pieces, of the shape shown in the figure, were arranged in the small 10-ton Buckton testing machine so that the load was applied in the directions indicated by the arrows.



Each specimen was tested to destruction and the breaking load noted. All specimens were carefully measured before testing.

The following table gives the results obtained:

Test piece cut from	Top a. × b. *Inches.*	Bottom a. × b. *Inches.*	Shearing area. *Sq. inches.*	Density. *lb. per cub. ft.*	Place of fracture.
Log A	1·96 × 2·07	1·98 × 2·07	4·04	48·8	Top
do.	1·99 × 2·06	1·97 × 2·07	4·08	47·1	Top
Log B	1·99 × 2·08	1·98 × 2·04	4·04	43·4	Bottom
do.	2·05 × 2·04	2·02 × 2·02	4·09	45·0	Bottom
Log C	1·95 × 2·06	1·98 × 2·07	4·08	42·6	Bottom
do.	1·92 × 2·06	2·03 × 2·07	4·18	46·2	Bottom

Test piece cut from	Shearing load. *lb.*	Shearing stress. *lb. per sq. in.*	Remarks.
Log A	5,080	1,260	Failed in shear proper.
do.	3,590	—	Failed in tension at knot; knot along top end at right angles to length.
Log B	4,330	1,070	Failed in shear proper.
do.	5,130	1,260	Failed in shear proper.
Log C	4,610	1,130	Failed partly in shear and also in tension.
do.	3,860	920	Failed in shear proper.

Remarks on the Results of the Mechanical Tests

It will be seen from the preceding tables that the results of the mechanical tests on the different test pieces show considerable variation, and the following comments may be offered:

Transverse Tests.—The values for the coefficient of transverse strength (modulus of rupture) range from 4,600 to 12,050 lb. per square inch in the different specimens, but eight of the ten pieces tested gave values of over 9,000 lb.

Table II. Compression Tests.

Test piece cut from	Width. *Inches.*	Depth. *Inches.*	Height. *Inches.*	Weight. *lb.*	Density. *lb. per cub. ft.*	Breaking load. *lb.*	Breaking stress. *lb. per sq. in.*	Remarks.
Log A	3·73	3·78	6·09	2·375	48·6	98,000	6,860	Knot at lower end.
do.	3·67	3·93	5·99	2·156	44·0	103,000	7,100	Sap wood and pith at sides.
do.	3·93	3·68	6·07	2·500	50·0	81,800	5,600	Pith on one side.
do.	3·75	3·75	6·03	2·375	49·0	80,000	5,600	Knot on one side.
Log B	3·78	3·78	6·20	2·810	55·6	103,000	7,200	Sound before test.
do.	3·77	3·77	6·10	2·500	50·5	98,000	3,850	Diagonal crack across end before test.
do.	3·77	3·77	6·00	2·125	43·7	96,000	3,800	Sap wood at one corner.
do.	3·80	3·80	6·02	2·125	43·0	106,000	7,050	Sound before test.
do.	3·77	3·82	6·08	—	42·5	95,000	6,600	Curly grain with knot at one side; pith down one edge with crack radiating to centre.
do.	3·83	3·90	6·09	—	46·0	71,300	2,800	Very knotty and unsound near knot before test.
do.	3·88	3·89	6·06	—	40·8	103,000	6,800	Sound but for small crack near corner before test.
do.	3·83	3·89	6·05	—	43·4	97,000	6,500	Sound before test, but knotty.
Log C	3·77	3·77	6·07	2·063	42·0	83,000	5,850	Knot at lower end.
do.	3·80	3·80	6·05	2·344	47·2	94,000	6,550	Sound before test.
do.	3·78	3·77	6·07	2·063	42·0	85,000	6,000	Crack at one end before test.
do.	3·78	3·77	6·02	2·344	48·0	93,000	6,600	Sound before test.
do.	3·78	3·76	6·04	—	47·3	90,000	6,330	Sound before test.
do.	3·77	3·79	6·09	—	43·5	70,500	4,940	Bad double crack down one side before test.
do.	3·78	3·77	6·04	—	45·5	83,000	5,800	Sound before test.
do.	3·80	3·81	6·03	—	41·8	72,400	5,000	Crack on one side before test.

In the case of the two lowest values, 4,600 and 7,550 lb. respectively, the test pieces were not very satisfactory.

The highest value found for the Nigerian teak is, however, very much lower than the average value given by a number of specimens of Burma teak tested in India (see tables below).

Compression Tests.—The results of these tests also show considerable variation, the values obtained ranging from 2,800 to 7,200 lb. per sq. in. in the different specimens. Sixteen of the twenty test pieces, however, gave values of 5,000 lb. or over. The highest result, viz. 7,200 lb. per sq. in., is approximately equal to the maximum values given by specimens of Burma teak, but the range is much greater in the Nigerian teak than in the Burma teak (see tables below).

Shearing Tests.—It will be observed that all but one of the test pieces failed in shear proper. The values recorded, viz. from 920 to 1,260 lb. per sq. in., are lower than those given for Burma teak (see tables below).

For comparison with the results of these tests on Nigerian teak the following figures for oak and Burma teak may be given. The figures for Burma teak are taken from the *Indian Forest Bulletin, No.* 14 (1913), "A further note on the relative strength of Natural and Plantation-grown Teak in Burma," by R. S. Pearson.

	Nigerian Teak. Variation. *Tons per sq. in.*	Nigerian Teak. Average. *Tons per sq. in.*	Oak. Average. *Tons per sq. in.*
Transverse tests . .	4·11 to 5·38 [1]	5·01 [1]	5·35
Compression tests . .	2·20 to 3·21 [2]	2·79 [2]	4·46
Shearing tests . . .	0·411 to 0·563	0·504	—

	Natural-grown Burma Teak. Variation. *Tons per sq. in.*	Natural-grown Burma Teak. Average. *Tons per sq. in.*	Plantation-grown Burma Teak. Variation. *Tons per sq. in.*	Plantation-grown Burma Teak. Average. *Tons per sq. in.*
Transverse tests:				
1. Plains-grown teak	6·43 to 8·68	7·21	6·34 to 8·24	7·16
2. Hill-grown teak .	5·90 to 7·99	7·20	5·17 to 9·70	7·54
Compression tests [3]:				
1. Plains-grown teak	2·45 to 3·22	2·89	2·20 to 3·05	2·69
2. Hill-grown teak .	2·19 to 3·30	2·85	2·47 to 3·76	3·15
Shearing tests:				
1. Plains-grown teak	0·505 to 0·937	0·718	0·562 to 0·720	0·626
2. Hill-grown teak .	0·625 to 0·885	0·736	0·505 to 0·797	0·672

[1] *The two lowest results have been rejected.*
[2] *The three lowest results have been rejected.*
[3] *Size of test pieces,* 2 × 2 × 4 *in.*

It is evident from these figures that the specimens of Nigerian teak dealt with in this report are inferior to Burma teak in transverse strength, but about equal to the latter wood in their resistance to compression. It must be remembered, however, that this sample from Nigeria is from a single comparatively young tree, and that it will be necessary to test a number of specimens of the wood from Nigeria before any trustworthy average figures can be obtained for comparison.

Mashuna Wood from Rhodesia

A sample of mashuna wood from Rhodesia was received in October 1907. It was stated in the letter accompanying the sample that the wood has been used to some extent by local waggon-makers and in mining, and that it is impervious to the attacks of white ants. No information was supplied as to the botanical source of the wood.

The specimen consisted of a log 4½ ft. long, 5 in. wide, and 4 in. thick.

It is a very hard, heavy wood of golden yellow colour, which darkens considerably on exposure to the air. It much resembles English elm in structure and figure.

Unlike most exotic hard woods of coarse grain it turns and planes moderately well without splitting or warping. It makes beautiful turned objects, the colour and the prettily marked grain showing up well on curved surfaces. It is, however, very fissile, and therefore somewhat troublesome to smooth both in planing and turning. For the same reason it does not take nails well. It takes glue fairly well, and is a good firewood.

The transverse strength of this timber is very great, being but little inferior to that of ash; it breaks with a long, fibrous fracture. The weight per cubic foot is 63½ lb.

This timber should be very useful locally for waggon building, house frames, and for other purposes where it can be used in large pieces and where strength is desirable. It would be of little use in thin boards, as these would split very easily.

It is unlikely that mashuna wood could be exported

profitably, as the cost of freight on such a heavy timber would prevent it competing successfully with other woods of equal merit which are already in possession of the market.

"MUKOKOTO" OR "MUTUMBWI" TIMBER (*PTERYGOTA* SP.) FROM UGANDA

The specimen of timber which is the subject of this report was forwarded for examination to the Imperial Institute in June 1912.

Herbarium specimens of the tree which were forwarded to Kew by the Chief Forestry Officer have been identified as a species (probably undescribed) of *Pterygota*.

The timber was submitted for examination to a technical expert, who furnished the following report:

In general appearance this wood is much like the commoner varieties of Ficus timber, being of a brownish-white colour, stained with blue throughout and in parts flecked with black. The wood is irregular in grain, and splits in a brittle manner like elm, although it is not so hard as the latter. It saws easily, but tears badly in planing.

The wood burns readily, leaving very little ash. It belongs to a class of timber commonly used in the tropics for packing-cases, and takes nails easily. The weight per cubic foot is 38 lb.

This mukokoto wood has no decorative qualities, and it could not be profitably shipped to Europe as timber.

"DUKA" (*TAPIRIRA* SP.) WOOD FROM BRITISH GUIANA

In connection with an enquiry as to the suitability of certain British Guiana timbers as substitutes for red cedar in the manufacture of cigar boxes, specimens of duka wood were forwarded to the Imperial Institute in July 1910.

According to a report furnished by the Forestry officer, British Guiana, to the Imperial Institute, duka is a species of *Tapirira*, allied to *T. guianensis*, Aubl. The tree occurs scattered singly in the forests of certain parts of the Colony, on the flat lands of sand and clay border-

ing the rivers and creeks, which are periodically inundated, and on slightly elevated lands or low hills of white sand. It is estimated that at such places where duka trees occur in the North West, Pomeroon and Demerara River Districts, the average number varies from one to three per acre, of an average girth of about 33 in., the largest tree measured being 63 in. in girth, but it is pointed out that probably not more than 50 per cent. of the trees are large enough for cutting. Large quantities of the wood therefore do not appear to be available. On the slightly elevated lands and low hills, the cost of transportation would prohibit the exploitation of the timber, unless it was cut along with woods of known commercial value such as "wallaba" (*Eperua* spp.), with which it is usually found associated in such situations. On the low-lying, swampy lands, however, where transportation is easier and cheaper, a limited quantity could be obtained. Two or three varieties of duka are stated to occur. According to the Hon. A. G. Bell (*On the Collection of Colony Woods at Plantation Christianburg*, Georgetown, Demerara, 1906), the wood can be obtained in logs up to 40 ft. in length, and squaring up to 17 in.

The samples received at the Imperial Institute consisted of three small planks of wood measuring 3 ft. by 9 in. by 1 in. The colour was pale dull red, somewhat resembling that of West African cedar, to which the wood was also similar in grain. The wood possessed a slight odour, which was not at all like that of cedar.

The wood was submitted in the first instance to cigar-box manufacturers for trial. An important company who manufacture and use a large quantity of cigar boxes reported that they considered the wood to be quite suitable for making a "second quality" of cigar boxes provided that the price was acceptable. They added that this duka wood had not the scent of cedar, but was otherwise not objectionable.

Another firm stated after an exhaustive trial of the wood that it was not suitable for the manufacture of cigar boxes for their purposes. They suggested, however, that the wood could be utilised in many other ways, if classed

as a hardwood and shipped in fair-sized planks at a reasonable price.

In order to confirm this last opinion a specimen of the wood was submitted to a firm of timber brokers, who stated that the wood is not known on the London market, and that the quality is not attractive, but that it might possibly find a sale in boards or planks as a substitute for mahogany. The price would, however, be low, say about 2*s.* 6*d.* per foot cube. The firm added that if a small trial shipment of the wood could be forwarded it would be possible to furnish a more detailed report as to its commercial possibilities.

PARA RUBBER FROM THE GOLD COAST

THE cultivation of *Hevea brasiliensis* has been undertaken very successfully in the Gold Coast at the Government Agricultural Stations, notably at Aburi and Tarquah, and in addition European planters have established a number of plantations, some of which have now reached the productive stage. The natives in many parts of the country are also devoting attention to the cultivation of the tree. The climatic and other conditions in the Gold Coast appear to be well suited to the growth of the tree, and tapping experiments carried out at the Agricultural Stations at Aburi and Tarquah have given good results (see this BULLETIN, 1912, **10**, 316; 1913, **11**, 161).

In 1912 two blocks of trees at Aburi were tapped (*Rep. Agric. Dept., Gold Coast*, 1912, p. 30). In each case the renewed bark was tapped on one-third of the circumference of each tree, in one case on the vertical-parallel system and in the other on the half-spiral system. The average yield of dry rubber per tree in the first block for 158 tappings spread over the whole year was 2 lb. 10½ oz., and in the second block 2 lb. 13 oz. for 156 tappings. These results show an increase of fully ½ lb. per tree as compared with the yields obtained in 1911.

At Tarquah thirty experimental trees, eight years old, with an average girth of 33·13 in., gave an average yield of 3 lb. 12 oz. of dry rubber per tree when tapped on alternate

days throughout [illegible]. This also is [illegible] on the results obtained in the previous year. At the same station 1,000 trees were tapped on alternate days for twelve months, the average yield of dry rubber per tree being 2 lb. 3 oz. as compared with 1½ lb. in 1911.

In all, 2,808 lb. of rubber obtained during tapping experiments in the Gold Coast were sold on the London market during 1912. The sheet and biscuit rubber realised an average price of over 4*s.* 3*d.* per lb., and the scrap rubber 2*s.* 11*d.* per lb., which were about the average market prices for plantation rubber.

A sample of smoked Para biscuits from trees thirteen years old growing at Aburi was received at the Imperial Institute in January 1914. The rubber was stated to have been prepared by the addition of acetic acid in the usual way and then dried in a smoke-chamber.

The biscuits were thin and brown in colour, possessing a strong smoky odour. The rubber was clean and well-prepared, and its physical properties were very satisfactory. It was examined chemically with the following results:

	Per cent.
Loss on washing (moisture and impurities)	0·8
Composition of dry, washed rubber:	
Caoutchouc	94·1
Resin	2·9
Protein	2·7
Ash	0·3

This rubber was of a very satisfactory quality, comparing favourably in composition with the best plantation Para rubber from the East. Consignments of similar rubber would always find a ready sale at the current market price. At the date of the report it was worth about 2*s.* 1*d.* per lb. (July 1914).

PARA RUBBER FROM SIERRA LEONE

In Sierra Leone the plantations of Hevea are at present on the experimental scale, and are worked under the supervision of the local Forest Administration. Two samples of Para rubber produced experimentally in Sierra Leone

were received at the Imperial Institute in October 1913. The results of their examination are given below.

No. 1. *Trees Six Years old; coagulated with Lime Juice and dried in Smoke.*—Small, irregular biscuits of rough appearance and almost black in colour. The rubber was rather weak, and broke fairly easily when stretched. It gave the following results on analysis:

	Per cent.
Loss on washing (moisture and impurities)	1·4
Composition of dry, washed rubber:	
Caoutchouc	94·0
Resin	2·6
Protein	2·8
Ash	0·6

This sample was possibly worth 1*s.* 9*d.* per lb. in London, with fine plantation biscuits at 2*s.* 2*d.* to 2*s.* 3¼*d.* per lb., and fine hard Para at 3*s.* 1*d.* per lb.

The rubber was of very satisfactory composition, comparing favourably in this respect with plantation Para rubber from the East; it was, however, of indifferent appearance, and rather deficient in elasticity and tenacity. Possibly the method of coagulation employed may have adversely affected the physical properties of the rubber, and it was suggested that it would be advisable to use acetic acid instead of lime juice for the purpose.

No. 2. *Trees Four to Five Years old; coagulated by Evaporation, dried in Air, and finally smoked.*—A few small biscuits of rubber and a small ball of scrap. The biscuits were pale brown, clean, and well prepared. The rubber exhibited fairly good physical properties, being much superior to sample No. 1 in this respect.

The biscuits were submitted to chemical analysis with the following results:

	Per cent.
Loss on washing (moisture and impurities)	1·0
Composition of dry, washed rubber:	
Caoutchouc	92·6
Resin	3·9
Protein	3·0
Ash	0·5

Biscuits similar to this sample would probably realise about 2*s.* per lb. in London, with fine plantation biscuits and fine hard Para at the prices quoted above.

This rubber was not quite so good as No. 1 in composition, but was much superior in appearance and physical properties. The latex should, however, be coagulated by the addition of acetic acid instead of by evaporation, as the latter method usually tends to increase the amounts of resin and protein in the rubber.

FUNTUMIA RUBBER FROM THE GOLD COAST

In previous numbers of this BULLETIN (1907, **5**, 250; 1910, **8**, 261; 1912, **10**, 384) accounts have been given of the results of examination at the Imperial Institute of samples of Funtumia rubber from the Gold Coast, prepared by coagulating the latex in various ways. In January of this year a further sample, prepared by the addition of 1 per cent. of formalin to the crude latex, and then dried in a smoking-chamber, was received. The latex was obtained from trees about nine years old, growing at Aburi.

The sample consisted of thin, irregular biscuits, varying in colour from light to dark brown, and having a strong smoky odour; some of the biscuits were rather rough in appearance. The rubber was clean, and its physical properties were very good. It was analysed with the following results:

	Per cent.
Loss on washing (moisture and impurities)	3·1
Composition of dry, washed rubber:	
Caoutchouc	81·7
Resin	10·1
Protein	7·5
Ash	0·7

This rubber contained rather high percentages of resin and protein, which reduce the amount of caoutchouc to 81·7 per cent. The physical properties of the rubber were, however, very good, and consignments of similar rubber would probably realise 1*s.* 10*d.* or 1*s.* 11*d.* per lb. in London at the date of the report (July 1914).

CEARA RUBBER FROM PAPUA

Two samples of Ceara rubber, stated to be the first prepared in Papua, were received at the Imperial Institute

in February 1914. The rubber was obtained from trees two to two and a half years old, growing on an estate on the Baubauguina River in the East-Central Division, and planted 11 ft. by 11 ft. The soil is a sandy loam, and the rainfall fairly heavy, averaging about 100 in. per annum.

The samples were as follows:

No. 1. *Sheet Rubber.* — This consisted of two sheets of pale brown rubber, $\frac{1}{16}$ in. in thickness, and measuring 15 in. by 10 in. and 18 in. by 11 in. respectively. The rubber was clean and well prepared, and its physical properties were satisfactory. It was analysed with the following results:

	Per cent.
Loss on washing (moisture and impurities)	1·4
Composition of dry, washed rubber:	
Caoutchouc	88·5
Resin	4·7
Protein	5·7
Ash	1·1

The results of the examination show that this rubber was of satisfactory composition, and there is no doubt that consignments of similar quality would be readily saleable. Its value at the date of the report was about 2*s.* per lb. (July 1914).

No. 2. *Scrap Rubber.*—This consisted of a block of aggregated shreds of brown rubber, with a somewhat mouldy smell. The rubber was slightly "tacky" in parts. It gave the following results on analysis:

	Per cent.
Loss on washing (moisture and impurities)	9·4
Composition of dry, washed rubber:	
Caoutchouc	82·3
Resin	3·2
Protein	11·5
Ash	3·0

This scrap rubber would not realise such a good price as the biscuits, and at the date of the report it was probably worth about 1*s.* 8*d.* per lb. in London (July 1914).

It will be seen from the analyses that, as usual, the scrap rubber contained a much higher percentage of protein than the biscuits.

SPECIAL ARTICLES

THIRD INTERNATIONAL CONGRESS OF TROPICAL AGRICULTURE, LONDON, 1914

THE Third International Congress of Tropical Agriculture opened at the Imperial Institute on Tuesday, June 23, and met daily, except on Saturday and Sunday, until Tuesday, June 30. A preliminary notice of the Congress and a provisional programme were published in this BULLETIN (1914, **12**, 79). The following is the President's opening address delivered at the Imperial Institute on Tuesday, June 23.

OPENING ADDRESS BY THE PRESIDENT,

PROFESSOR WYNDHAM R. DUNSTAN,
C.M.G., M.A., LL.D., F.R.S.,

Director of the Imperial Institute

THE International Congress of Tropical Agriculture, which we meet to open to-day, is the third which has been held under the auspices of the International Association for Tropical Agriculture, the first having taken place in Paris in 1905 and the second in Brussels in 1910. At the close of the Brussels Congress the members of the Association did me the honour to elect me as President of the Association in succession to the veteran M. de Lanessan, who, as Governor-General of Indo-China, and afterwards as Minister responsible for the French Colonies in the Government of the Republic, did so much, through his intimate knowledge of the scientific problems of tropical agriculture, to promote its advancement in the French tropics. Fortunately we have continued to enjoy the advantage of M. de Lanessan's advice and assistance in the affairs of the Association which owes so much to his guidance. We all regret that continued ill-health prevents us from welcoming him, the *doyen* of the Association, among us to-day.

I accepted with considerable diffidence the honour so generously pressed on me by my Continental colleagues,

as among the many responsibilities it involved was that of carrying out the unanimous wish of the members of the Association that the next International Congress should be held in London.

Whatever success the present Congress may achieve is due to the co-operation in the work of organisation of the few members of the British Committee who are resident in London, and above all to the unremitting labours of the Honorary Organising Secretaries, Dr. Henry and Mr. Harold Brown. It is satisfactory that as a result of a year's arduous work an assemblage of distinguished men of all nations and an embarrassing wealth of communications on every aspect of tropical agriculture are the salient features of the Third International Congress of Tropical Agriculture.

His Majesty the King has shown his interest in our proceedings, and has recognised their importance by graciously consenting to become Patron of the London Congress. We have among the Honorary Vice-Presidents the Ambassadors in London of the Powers concerned in tropical agriculture, His Majesty's Principal Secretaries of State, the Viceroy of India, and other distinguished men who are or who have been connected with administration in the tropics.

The idea of co-operation and interchange of opinion among those of different nationalities who are engaged in the same work and who are working for the same end is undoubtedly a valuable one, and its realisation has been productive of most useful results in several important instances, so much so indeed that International Congresses of all kinds, great and small, on all sorts of subjects have become very numerous in recent years. This is a significant development of the times which no one would desire to deprecate on general grounds. Yet from their great number the danger now is that the importance of those which deal with subjects of great public moment is apt to be overlooked.

There is no subject at the present time in the whole field of human activity which demands greater attention than the organisation of those agencies which make for

the agricultural productivity of the tropical regions of the world. The subject is of importance to the native races of the tropics who are coming more and more under European control and influence, and who look to European knowledge and experience for guidance in increasing the productivity of the soil.

It is of no less importance to all Governments of tropical countries, which are principally concerned in securing under good governance their material and commercial advancement.

Moreover, the temperate world has to depend on the tropics for the supply of numerous materials which have become necessaries of life and the basis of some of the most important manufacturing industries of modern times.

A Congress which meets to consider and discuss the problems of tropical agriculture in their widest bearings is therefore of the highest importance to all civilised nations. It has been our endeavour to make this, the Third International Congress of Tropical Agriculture, which meets for the first time in the principal city of the British Empire, a thoroughly representative and successful one, of value not only to this country and to the Empire whose tropical interests are so extensive, but also to those other nations whose representatives we welcome here to-day.

I should like very briefly to indicate the principal objects which the British Committee have kept in view in organising the present Congress. The topics of first importance to the advancement of tropical agriculture have been given a prominent place in the proceedings of the Congress. Education, research, legislative enactments relating to plant diseases, tropical sanitation and hygiene, credit banks and co-operative societies are to be considered at meetings of the Congress, as are also such important problems of general interest at the present time as the improvement of cotton cultivation, the fertility of soils in the tropics, the production of fibres, and the preparation of plantation rubber. Sectional meetings will be devoted to the discussion of papers on each

important group of agricultural products, where also technical questions connected with soils and manures will be considered.

Special papers on several subjects of general interest will also be given.

The advancement of tropical agriculture must chiefly depend on the labours of the specialist, the practical agriculturist and the investigator, whose contributions form the groundwork of our Congress. It is, however, important that the directions of advance, the nature of the problems to be solved, and the methods which have to be followed in solving them, should be generally understood, and their great importance appreciated by two other classes in the community: by administrators and officials of Governments, and by manufacturers, merchants, and other users of the agricultural products of the tropics.

The advance of tropical agriculture by scientific methods needs the interest and support of those who have the duty and responsibility of administering the Governments of tropical countries, as well as of the users of the raw materials, the representatives of the great manufacturing industries. For this reason the assistance in the work of the Congress has been secured of a number of distinguished Government representatives, and also of manufacturers, companies, and firms who make use of tropical agricultural products.

The list of Honorary Vice-Presidents will show that we have enlisted the interest and support for the Congress of a large number of distinguished Government representatives responsible for administration in the tropics.

It has been the endeavour to bring together scientific and practical authorities on tropical agriculture, and representatives of the great tropical planting industries, representatives of the Governments of tropical countries, and representatives of the industrial and mercantile community concerned in the utilisation of tropical agricultural products. In this I think we may claim to have been highly successful. We have a large attendance of tropical agriculturists, scientific and practical, from nearly if not

every country concerned. The number of papers on technical subjects exceeds 200, including within their scope almost every aspect of tropical agriculture. It will not be possible indeed within the week which is assigned to the Congress to get through our work unless we can depend on the co-operation of the many authors who are present in person, and on those who take part in the discussions in observing the utmost brevity in addressing the meetings, by confining themselves to essential points, and remembering that papers will be printed in the *Transactions* of the Congress.

As it is also hoped to print the principal contributions to the discussions, those who take part in them are requested to assist our work by sending to the Secretaries after the meetings succinct written reports of their remarks.

It has been decided to consider a selection of subjects of general importance at General Meetings of the Congress, and at certain of these meetings it has been arranged for the chair to be occupied by well-known representatives of Governments or of industries, to whom the advancement of tropical agriculture is of vital importance. The improvement of cotton cultivation is to be considered at a General Meeting on June 29, when I am happy to announce that Lord Kitchener, one of our Honorary Vice-Presidents, will take the chair. Lord Kitchener represents a country in which agriculture is the chief industry, and he has shown the greatest interest in its advancement, and that of the great cotton-growing industry in Egypt. Following a discussion of problems connected with the preparation and quality of plantation rubber a series of important papers on rubber will be read at a meeting on June 25, at which Sir Edward Rosling, formerly Member of the Legislative Council and Chairman of the Planters' Association of Ceylon, will be in the chair. Questions connected with the cultivation of wheat and other cereals will be discussed at a meeting on the same day, at which Sir Louis Dane, lately Lieutenant-Governor of the Punjab, will take the chair. Co-operative Credit Societies and Banks will form the subject of another meeting, at which

Sir Horace Plunkett will take the chair. Sir Ronald Ross will preside at a discussion on Sanitation and Hygiene on Tropical Estates.

The Congress is especially indebted to the Secretary of State for the Colonies, one of our Honorary Vice-Presidents, who is to preside at a meeting at which the cultivation of cotton is to be discussed. Mr. Harcourt has shown great personal interest and has rendered valuable assistance in the organisation of this Congress.

Sectional meetings will be held to discuss papers on cotton, rubber, cocoa, tobacco, and fibres. At the meeting at which cocoa is to be considered the chair will be taken by Sir Hugh Clifford, the Governor of the Gold Coast, where cocoa cultivation has made enormous strides in recent years. At the meeting at which papers on Jute and Hemp Fibres will be read, Mr. C. C. McLeod, Chairman of the London Jute Association, will take the chair.

A special paper will be read on the Work of the British Cotton Growing Association by the Chairman, Mr. J. Arthur Hutton, at which Lord Derby, the President of the Association, will take the chair. Lord Emmott, Under-Secretary of State for the Colonies and a member of a firm of cotton spinners, will be among the speakers. Other special papers are on the Fibre Industry of British East Africa, by Mr. Alfred Wigglesworth; on the Utilisation of Sun Power for Irrigation and other Purposes in Tropical Agriculture, by Mr. Frank Shuman; and on the Karakul Sheep, by Prof. Wallace.

In order to get through our work it will be necessary to meet in the afternoons as well as in the mornings, and to commence the proceedings as a rule at 10.30 in the morning, with an interval of about an hour in the middle of the day, and of half an hour in the afternoon, the work of the meetings terminating at 6 p.m.

Some Recent Advances in Tropical Agriculture

In the four years which have elapsed since the last International Congress met in Brussels many important developments in tropical agriculture have taken place which will form the subject of papers and discussion at

our meetings, and to which I shall be able only very briefly to allude in this address.

An immense impetus has been given to the cultivation of rubber, chiefly through the largely increased demand which has arisen for rubber tyres owing to the perfection and general use of motor vehicles. The increased demand occurred at a time when but few of the larger rubber plantations in the East had come into full bearing. A rapid and unprecedented rise in the market price of the raw material took place, and as a result new plantations were initiated in every country, especially in Asia and Africa, in which rubber can be grown, as well as in some places where the chances of success were very small. During this period rubber trees of every description were grown in plantations on a large scale, of which Hevea, Ceara, and Castilloa are the most important. A struggle has since been in progress from which we are now beginning to emerge. There has been not only competition between the rubber of these plantations and the rubber derived from the forests of South and Central America and Africa, the result of which mainly turns on cost of production, but there has also been competition between the rubber of plantations of Hevea, of Ceara, and of Castilloa, the result of which turns not only on cost of production, but also on the yield and quality of the crude rubbers furnished by these different trees. Certain conclusions are already definitely indicated. One is that the high reputation of the Hevea tree as a rubber producer in countries in which natural conditions are favourable to its growth is established beyond all question. Ceara and Castilloa trees, however, undoubtedly have possibilities in other countries, the climate and soil of which are unsuitable for *Hevea brasiliensis*. The production of rubber from Castilloa trees in plantations is confronted with special problems which are to be discussed at one of our meetings.

It is, moreover, established that under existing conditions rubber from Hevea plantations can be produced at a smaller cost than the same rubber collected from forest trees in the Amazon region of South America.

Two questions remain. One is as to the maintenance of an ample supply of cheap labour for the plantations of the Eastern tropics; the other, with which we are more immediately concerned, is as to the quality of the rubber produced in plantations as compared with that of the rubber obtained from the trees of the forests of South America. The latter question is to form the subject of a special discussion at one of the meetings of the Congress, at which it is hoped that, as the result of an interchange of views between specialists, planters, and manufacturers, some further light may be thrown on this important question. I need not now do more than remark that the evidence that plantation rubber obtained by satisfactory methods from well-established trees and properly prepared is equal in quality to that of forest trees is too strong to be doubted. We have yet to learn the precise cause of variations which it is alleged are sometimes shown by plantation rubber, and which are said to interfere with its uses for some manufacturing purposes.

Before leaving the subject of rubber production I ought to allude to the artificial production of this material by chemical means, which has now been satisfactorily accomplished by laboratory methods. It has still to be proved that these laboratory methods can be successfully translated into operations on a large scale, so as to produce commercially rubber of high quality, and cheaply enough to compete with natural rubber. The improvement of plantation rubber and the cheapening of its cost are the main problems for the rubber grower. The possible success of synthetic rubber is generally regarded as the bogy of the rubber industry, and the success of synthetic indigo is often quoted as an ominous precedent. It is indeed an important precedent, but in a different sense. The indigo planter did not realise, until it was too late, the fact that improvements in methods of production and cheapening of cost were the vital problems, and that the best hope for the future of the industry lay in the direction of systematic and continuous investigation with a view to the solution of these questions. While these very problems in connection with the production of

synthetic indigo were engaging the close attention of investigators in Germany, little or nothing was being done by planters to improve the natural production. The moral is obvious, and is, I think, fully realised by leading rubber planters. Already important improvements in production have been carried out, and the cost of production has now been so considerably reduced on many estates that the commercial success of synthetic rubber seems a highly improbable contingency.

In all industries risks have, of course, to be taken, and there are some against which no human foresight can provide. It has more than once been suggested that it is by no means without the range of possibility that tyres might be constructed on a different principle, involving the use of metal with little or even no rubber. The way to minimise this risk is to extend the industrial uses to which rubber is applied, and definite steps are, it is understood, now being taken to this end.

I have made this brief allusion to the rubber problems of to-day because they point to a condition of affairs which, so long as it is allowed to continue, is a serious menace to the proper progress of tropical agriculture. The extraordinary development of the rubber-growing industry has, from the scientific standpoint, taken us unawares. A large and rapidly increasing industry was suddenly confronted with a number of questions which no one could properly answer, for the good reason that the necessary knowledge did not exist. The exact origin, nature, and functions in the tree of the latex which carries the rubber were not known, and are not precisely known even to-day. These problems belong mainly to the regions of botanical physiology and of chemistry, but had been little investigated. They lie at the root of the many practical questions which arise in connection with the production and flow of latex, the relation of latex production to the nutrition of the tree, and the methods of securing a steady production of latex without undue interference with the vitality and growth of the tree. Little was known as to the effect on the tree of the continuous removal of latex or of the relative effect of different methods

of tapping. The consequence was that these investigations have had to be carried out while the plantations waited for the knowledge, which has now been largely gained in part through observations and experiments made by practical planters.

The number of trained investigators in the tropics has been so small that there are large gaps in our knowledge which can only be slowly filled. The entire subject of the science of growing rubber trees in plantations should receive continuous investigation by trained specialists. The fungoid diseases to which the rubber trees are subject, and the insect attacks to which they are exposed, are no less important to the rubber grower than those which relate to the life-history of the plant, its physiology, and nutrition. It must be admitted that the scientific means of defence had not been prepared, and that we were not ready for action at a moment of weakness. To this general question of technical education and research, which is to be considered at more than one of our meetings, I shall return in another part of this address.

Another subject which will claim much of our attention at this Congress is the large and important one of cotton growing and its improvement. Lord Kitchener is to preside at one of several meetings on this question, when cultivation in Egypt will be considered, and at another Mr. J. Arthur Hutton, the Chairman of the British Cotton Growing Association, will give an account of the great work which that Association has done in the last twelve years to extend and improve the cultivation of cotton within the British Empire, and to open up new fields of supply for the mills of Lancashire. Herr Schanz in another paper will describe the advances in cotton cultivation in the German Colonies. Again we are confronted with problems which need for their solution continuous scientific investigation and systematic experiment, and here again adequate means of research were not available in the first instance, and in some cases are not completely provided now. The discovery of a kind of cotton capable of being acclimatised in a new country, and possessing the characters which will render its production profitable, is one which requires

time for its solution. In addition to the well-known process of seed selection, the newer methods of plant breeding require to be tried in a well-considered scheme of work in which both practical agriculturists and trained specialists can act in co-operation. Some notable advances have been made, especially in India, in Nyasaland, Uganda, in French West Africa, and in German East Africa, but the fact cannot be too strongly emphasised that what is needed is continuous effort and experimental work in each country in which cotton cultivation promises success.

Whilst we in this country are naturally concerned in the first instance to improve and increase cotton cultivation within the British Empire, it is to the advantage of all nations that the world's supply of good cotton should be increased. It is of importance, therefore, that those engaged in this work in different parts of the world should occasionally meet together to compare notes and exchange views, and for this reason the value of an International Congress such as this cannot be over-estimated.

In this country at the present time we are specially and financially interested in a large attempt, chiefly due to the initiative of Lord Kitchener, which is about to be made to grow Egyptian cotton under irrigation in the Gezira district of the Anglo-Egyptian Sudan, an enterprise which will require not only sound, practical management, but also careful experiment, close supervision, and cautious advance under the advice of specialists in cotton cultivation.

I think I may safely say that Lancashire spinners, while greatly interested in this enterprise, would view with satisfaction a similar development on the opposite shore of the Mediterranean. Asia Minor, which I visited a few years ago, appeared to me to offer a promising and very large field for the growth of long-stapled American Upland cotton of a type which is in great demand not only in Lancashire, but also throughout the Continent of Europe.

With the advent of irrigation in Mesopotamia additional possibilities for cotton growing in Asia Minor are opened up. With the development for cotton growing in these

great tracts, in Egypt, the Sudan, and in Asia Minor the demands of Europe for two of the principal grades of cotton would in a very large measure be met, and the principal manufacturing requirements of the Old World largely derived from within its confines.

In this connection importance must also be attached to the advances which are being made in improving and extending cotton cultivation in India, which are to form the subject of communications to the Congress.

The dividing line between forestry and agriculture is not easy to draw, especially when we attempt to classify agricultural and forest products. There has been in the last few years an important advance in a subject which lies at present, perhaps, within the domain of forestry, since the materials are largely obtained from naturally occurring trees in the forests. I refer to the oil-yielding trees, especially those which furnish oils suitable for the manufacture of soap or for other purposes. Oils which are edible are now in large demand for the manufacture of those preparations now so widely used in cooking, which under various names are partly or wholly composed of vegetable oils or fats. The result of the demand for certain oils for edible purposes which were formerly used for soap-making has led not only to a rise in the price of these materials, but to a demand on the part of the soap-maker for the supply of other and cheaper oils suitable for his purpose. The oils now in demand include cotton seed, arachis (ground nut), sesame, and some others, which may be regarded as agricultural products, as the plants are grown as crops in the field. Coconut oil, palm oil, and palm-kernel oil are three of the most important of vegetable oils used for soap-making, and more recently for edible purposes. Coconuts have passed into the domain of agriculture, being now cultivated in plantations. The proper cultivation of these palms is a subject of great importance which requires serious attention. The habit, nature of growth, and of nutrition in relation to productivity require study from the plant physiologist; the diseases, fungoid and insect, to which the coconut palm is subject, and the treatment of the soil and manuring

of plantations, are matters in which our knowledge is fragmentary and incomplete, and which should receive attention, in view of the great commercial importance of this crop. The West African oil palm is another most important source of two oils respectively derived from the pericarp of the fruits of this palm and from the kernels of the seeds. The oil or fat furnished by the pericarp, and roughly extracted by native methods, was, not many years ago, familiar as the orange-coloured lubricating grease employed on railways. At a later period a demand at an increased price arose for its use in connection with soap manufacture. More recently attention has been turned to improvements in extracting and preparing palm oil, with the result that a material devoid of the objectionable colour and flavour of crude palm oil has been obtained which seems likely to be in demand at remunerative prices for edible purposes. The subject of the growth and treatment of the African oil palm is one which is beginning to demand serious study. This question of palm oil is to come before the Congress at one of the sectional meetings, when we shall have an opportunity of congratulating our French and German colleagues on their activities in improving the methods for its extraction, from which more than one British industry will gain.

Before I leave this brief reference to some of the more important advances which have occurred since the Congress met in Brussels, I must refer to a remarkable change which has taken place with reference to the production of cocoa, the principal centre of which is now the British Colony of the Gold Coast. There was an output of 11,407,608 lb. in 1905, when the Congress met in Brussels. It had risen to 45,277,606 lb. in 1910, and last year (1913) it was 113,239,980 lb., and therefore this country now stands first on the list of cocoa-producing countries. This remarkable result is not merely due to labour difficulties in other cocoa-producing countries; in fact, the Gold Coast is not free from these difficulties itself. It is mainly due to the fact that the climate of the Gold Coast over a large area has proved to be particularly well adapted to the growth of cocoa, whilst the native farmers, with advice and assistance

from the local Department of Agriculture, have taken up the subject with great energy and success.

The cocoa industry of the Gold Coast is in fact a notable example of an enterprise which has been brought to success as a native industry aided, and to some extent supervised, by Government, but without pressure or coercion in any form.

A paper on the subject by the Director of the Agricultural Department of the Gold Coast is to be read at one of the sectional meetings of the Congress, when we shall have the advantage of the presence of Sir Hugh Clifford, the Governor of the Colony which looks, under his guidance, to other developments in agriculture, in which he is known to take so great an interest.

If, in concluding this review, I refer to tobacco and sugar, it is only to draw attention to a community of interests in temperate and tropical agriculture, which it was another object of the organisers of this Congress to foster. We are glad to welcome on our General Committee and at our meetings a number of distinguished representatives of agriculture in this country. Tobacco is one of several crops which have taken their place in temperate as well as in tropical regions. It has, of course, been known for long that the tobacco plant could be grown in sub-tropical and temperate regions, but recent developments indicate that certain kinds of tobacco may not only be grown, but successfully cured of satisfactory quality in a number of new areas, among which may be mentioned Canada, South Africa, including Rhodesia, and Ireland, whilst promising trials are being made in this country. The subject is one which needs increased attention in the tropics, especially in relation to the growth of cigar tobacco.

In the short period under review great strides have been made in the region of tropical medicine and hygiene. Our knowledge of several important tropical diseases is now sufficiently complete to enable remedial and preventive measures to be taken with so great a success that, provided certain precautions are taken, life in the tropics is deprived of many of its dangers.

The Imperial Institute a Centre for Information

As we are assembled for our Congress in the Imperial Institute, I may draw attention to the necessity for a sort of Central Clearing House for collecting and supplying trustworthy information on all subjects connected with tropical agriculture, and especially with their technical and commercial aspects. The Imperial Institute during recent years has been identified with investigations and reports chiefly as to the value for technical and commercial purposes of tropical agricultural products of all kinds. A large staff of men who have specialised in these products and their uses are at work in the laboratories of the Scientific and Technical Department.

The Institute is in communication with Agricultural Departments in India and the Colonies on all these subjects, as well as with manufacturers and users of tropical materials at home and abroad, for whose benefit classified sample rooms are maintained, and the important products of the British tropics exhibited in Public Galleries.

The Imperial Institute is also called upon to afford special information respecting every aspect of tropical agriculture and its products, which it is specially qualified to procure and supply through its communications, both with the countries concerned and with manufacturers. Much of the information thus collected hitherto has been published from time to time in the quarterly *Bulletin of the Imperial Institute*, and in special reports, also published. The work has, however, now grown to an extent which requires a separate organisation to cope with it, and this is now being arranged. It is to be known as the Technical Information Bureau, and it will serve as a centre from which trustworthy information with reference to the production and utilisation of tropical agricultural materials of all kinds will be issued, and the Bureau will from time to time publish reports for the benefit of the agriculturist in the tropics as well as of the manufacturer at home.

Technical Education in Tropical Agriculture

I desire now to pass to a subject of great importance to this Congress as vitally affecting both the status and the achievements of tropical agriculture. I refer to the provision of technical education for those who desire to make tropical agriculture the work of their lives. The subject is one which is claiming the consideration of all nations with interests in the tropics, and more especially of this country, whose tropical interests, direct and indirect, are greater than those of any other nation in the world.

In several countries steps have been taken to provide agricultural education for the natives. I do not propose to deal principally with this question, although reference to it is necessary as the subject is intimately connected with the point to which I desire to direct special attention, which is the technical education of Europeans who are called to fill responsible agricultural positions in the tropics, whether as teachers of natives, officers of Government Departments of Agriculture, or supervisors, managers, or assistants on tropical estates. At the present time the education of men who are to fill these important positions is not definitely provided for, but is left to chance. In order to confine myself within the limits of a Presidential Address in a matter of the first importance which is to receive special consideration in meetings of this Congress, I shall confine my remarks chiefly to this question in its relation to the tropical possessions of Great Britain, and in doing this I wish to emphasise its great national importance.

The agricultural development of British tropical countries has made remarkable strides during recent years. This progress is of especial interest, since it has been achieved in the main by the employment of British capital, several hundred millions sterling being now invested in agricultural undertakings in the tropics. It has, moreover, led to a largely increased output from British sources of some of the most important raw materials of industry and commerce, of which it is sufficient to mention only cotton

and other fibres, rubber, cocoa, and tea. As a consequence of British initiative, the natives of the countries concerned have profited through increased trade and general prosperity, and also through the great need which has arisen for the employment of labour on a large scale, under satisfactory conditions and at rates of remuneration which show a steady increase. The native labourer is now fairly remunerated, well treated, and well provided for in matters of food and general sanitation. The native capitalist has been given every facility to embark on agricultural operations on modern lines, and he owes much to the example and enterprise of the European planter, as well as to the assistance of the Government.

With this material progress has come, somewhat slowly, the recognition of the fact that tropical agriculture is an applied science, and the reflection that progress would have been more rapid and less costly had it been effected more generally under that enlightened direction which depends on the considered application of scientific principles.

Agriculture in Europe is now thoroughly alive to these important considerations, and agricultural education is everywhere regarded as an essential preliminary to agricultural practice. Tropical agriculture has, however, only just reached this position, and its progress so far has been in the main effected by men who have had to learn at their own cost, or at the cost of their employers, the intricacies of a subject in which only accumulated experience and native shrewdness were available as guides. The partial successes of the past afford, however, no reason for delaying an advance which has been made in all other professions, in which a system of technical education has replaced one of apprenticeship. The apprenticed apothecary of the past was successful in his own time, but he is now replaced by the scientifically educated and technically trained physician and surgeon, and no one would dream of reverting to a system of apprenticeship in place of the thoroughly equipped medical schools of to-day. The European farmer and employer of agricultural labour is now usually an educated man who has

passed through the curriculum of one of the many efficient agricultural colleges which exist in this country and, indeed, throughout Europe.

The time has come to consider how education in tropical agriculture can best be provided. The opening up of new countries such as East, West, and Central Africa by European enterprise in agriculture has greatly increased the demand for men who are properly qualified to undertake such pioneer work. At present the means of learning the essentials of tropical agriculture usually consist in undergoing, with or without previous knowledge of temperate agriculture, a system of apprenticeship, in which all the difficulties and disadvantages of this antiquated system of learning are apparent. In what is now known as the Middle East, in India, Ceylon, and Malaya, the young man new to the tropics, usually without any agricultural experience, is apprenticed as a "creeper," and learns the ordinary procedure of the estate whilst entrusted with more or less responsible duties of management and supervision. Many of the larger planting companies are beginning to recognise the inadequacy of this plan of providing for the supreme management of estates on which from time to time arise problems which no amount of accumulated experience and judgment are competent alone to resolve. As a result, men are now beginning to be selected as assistants who have previously passed through the course of an agricultural college at home, and who have only to learn the special methods and problems of tropical agriculture during their career as apprentices. This step in selecting partially educated men is a significant and satisfactory advance in the right direction. The men thus selected have received a training in those sciences, such as chemistry and botany, on which the practice of tropical, as of temperate, agriculture depends. They have also gained some knowledge of general agricultural procedure and of estate management, all of which is of distinct value. They are, however, wholly unacquainted with tropical conditions and problems, and know nothing of the existing practice as regards the cultivation of tropical crops, whilst they are wholly ignorant of even the

principles of the management of native labour and of the routine to be followed in the growth of tea, rubber, coffee and cocoa, and tropical foodstuffs. The problems and difficulties which confront them in these subjects are beyond their previous experience and training.

It has to be recognised that it is necessary before a man, even with a diploma in European agriculture, can take an effective part in the management of a tropical agricultural estate, or play any important part in improving agricultural methods and solving special problems, or in teaching agriculture to natives, to have been well trained and thoroughly well informed as to the fundamental facts and conditions of tropical agriculture, which differ widely from those met with in temperate agriculture.

I have referred to the state of affairs as regards the great estates and planting companies all over the British tropics. The position is even less satisfactory as regards the Europeans who go out as teachers in native schools and colleges in the tropics, who, if they have enjoyed the advantage of having studied in an agricultural college at home before proceeding to their duties in the tropics, which is not always the case, are placed in the false position of having to teach agriculture under conditions with which they are wholly unacquainted, and as to which the special knowledge required can, under the circumstances, only be gained whilst they are filling the position of teachers and not of learners. Added to this fundamental defect is that of unfamiliarity with tropical climate and conditions of life and with the mind of the native. After some years a few of these men acquire, under unsatisfactory conditions, the knowledge required, and make efficient teachers, but there is little to be urged in favour of such a haphazard method of dealing with the subject.

The case of Government officials in agricultural departments in the tropics is more serious and even less satisfactory, since men without any experience of the problems of tropical agriculture are often presented as authorities to the native agriculturists. The natives are often men of large knowledge and experience of tropical agricultural practice, which is the foundation from which the European

should work. A number of men, especially those with previous agricultural experience at home, have managed during their periods of office to acquire, sooner or later, the necessary fundamental knowledge, and to become efficient officers. This, however, is no excuse for not providing a proper education for such officers adapted to the purposes in view. Experiments and new departures in tropical agriculture cannot be properly made, or advice safely given to natives, unless the European officer is thoroughly acquainted with the fundamental facts and conditions of tropical practice.

An Imperial College of Tropical Agriculture

What is now urgently required is an agricultural college in the tropics to which men with the diploma of an agricultural college at home can proceed, to receive a technical education in the subject and thoroughly qualify themselves for the profession of tropical agriculture.

In India agricultural colleges have been founded in recent years, but the courses of instruction provided are chiefly designed to meet the needs of native students, and are not adapted to the purpose of the European student, who comes equipped with some knowledge of general agricultural principles. The same objection applies to the otherwise excellent Agricultural School at Giza in Egypt. In the Southern United States of America several agricultural colleges exist in which special courses are given in sub-tropical cultivation, and where the European student may gain important knowledge respecting the problems of cotton and maize, tobacco and sugar growing. These institutions, not being situated within the tropical zone, do not, however, afford all that special experience and knowledge of certain crops which are essential for the students whose needs are now being considered.

No one who has studied this question in its many aspects can doubt that great need exists for the establishment within the British tropics of at least one agricultural college, properly equipped with all the facilities for instruction and research in the several branches of tropical

agriculture. Nor can it be doubted that well-trained men with the diploma of such a college will readily find remunerative employment. Beyond the immediate requirements of the ordinary student such a college should become a most important centre of tropical agricultural research, not merely for its own advanced students, but for trained investigators of special subjects from all parts of the world, who would there find ample materials and opportunities for their researches.

The question, therefore, is how best to realise the conditions necessary for the establishment of such a college. To begin with, it is essential to provide a thoroughly well equipped central college which shall serve the needs of those countries for which at the present time there is the greatest demand for trained agriculturists. The tropical countries of the British Empire are, however, scattered, and differ much in their agricultural conditions and needs. It is therefore to be anticipated that the successful establishment of one college will be rapidly followed by others in different countries. It can hardly be questioned that, all things considered, the area now called the Middle East has the first and best claim to be the site of such an institution, and that Ceylon is the country best adapted for the purpose. Ceylon is already the centre of a large agricultural community, both native and European. Openings for well-trained men are numerous and well paid, whilst the general conditions of agricultural practice resemble those of the Straits Settlements and Malay States and Southern India, and also afford a satisfactory training-ground for the agriculturist in tropical Africa. Ceylon has a variety of climates, and offers illustrations of the growth of a variety of crops. In particular it is a great centre of agricultural production, and occupies a leading position in the tea and rubber production of the world. In addition to presenting a satisfactory climate and a healthy environment for young Europeans, it is within comparatively easy reach of home. It contains at Peradeniya tropical gardens with specimens of the most important tropical plants of the world, and is

now provided with a Government Agricultural Department, with a staff of botanical, chemical, and entomological experts who would be able to render important service to such a college as is proposed. Without in any way desiring to underrate the importance of establishing a similar college in the West Indies or in other parts of the tropics, there is, I think, general agreement that Ceylon is the colony best adapted in every respect for the establishment of the first College of Tropical Agriculture which will efficiently serve at least the needs of the whole of the Middle East and of Eastern and Central Africa.

The Government of Ceylon is understood to be favourable to the proposal, and the Secretary of State for the Colonies has declared his interest in and sympathy with the scheme. It is welcomed by the large companies whose estates cover so large a part of the island, and who are ready not only to offer paid positions to those who obtain the diploma of the college, but in addition are willing to assist in obtaining the funds required, which, it is estimated, will amount to about £50,000. It is hoped that the Government of Ceylon, as well as the Governments of other countries interested, will give financial assistance to a scheme which promises to have far-reaching consequences in promoting the prosperity of the British tropics, and is not to be regarded as of benefit only to the colony in which the college will be placed, but as serving an Imperial purpose. There is another important reason why the Governments of the Eastern British tropics should financially assist its establishment. In every British colony there exists, at all events, the rudiments of an Agricultural Department, more or less completely equipped for the purpose of conducting experimental work in agriculture for the benefit of the colony as a whole, and of affording assistance and advice to the resident agriculturist, native and European. It is obvious that if such a department is to be in a position to discharge these responsible duties its work must be directed by an officer who is a master of his subject, and who can discuss agricultural problems

with as much practical knowledge and experience as the average agriculturists of the country in which he is to occupy the position of chief agricultural adviser.

It is well known that men fully qualified to act as Directors of Government Agricultural Departments in the British tropics are very difficult and often impossible to secure. Apart from the usual difficulty in finding men who combine some administrative capacity with the requisite technical knowledge, the main trouble is that there is at present no systematic means of educating and training a tropical agriculturist, and the men who to-day occupy these positions are usually botanists or chemists who have trained themselves whilst in office. It is admitted that these men have often been able to render distinguished service, but it must now be recognised that the absence of any system of education under which such officers can be trained for their responsible duties is one which calls for immediate attention. The present difficulty which Governments find in filling such posts would be removed by the establishment of the College of Tropical Agriculture, since each year a number of thoroughly qualified men with the diploma of the college would be available to select from. There are, therefore, strong reasons why Governments should do everything to support, financially and otherwise, a scheme for providing technical education in tropical agriculture, destined to promote objects which it is to the interest of Governments to secure.

Apart from the contributions of Governments and of companies there is need for private benefaction, especially on the part of the many in this country who owe their wealth to their association with tropical agriculture. It is therefore desirable to give some details of the scheme which has been prepared by the London Committee for the establishment of an Imperial College of Tropical Agriculture.

It is proposed, if the proper arrangements can be secured, to place the College at Peradeniya, in Ceylon, in proximity to the famous gardens and also to the Government Agricultural Department. Here, at an ele-

vation of 1,600 ft. and in a healthy climate and fine surroundings, will stand the college buildings, with laboratories and lecture rooms. The courses of instruction will be supervised by the Principal. Instruction will be open to all those who produce the diploma of an agricultural college or other evidence of possessing the preliminary knowledge requisite for attendance at such special courses. As educated and otherwise properly qualified native students will be admitted, as well as European students, it is intended to erect in proximity to the college at least two residential hostels, one or more for Europeans, and others as required for native students, each in charge of a bursar.

In addition to the teaching given at the college, arrangements will be made for the students, in groups, to visit for short periods other agricultural centres in the island, and there study agricultural problems on large estates. The entire course of work will occupy a period of one year, which will be continuous, and would, therefore, be equivalent to about two years' work at a university or college at home in which actual residence, apart from vacations, does not much exceed six months in each year. In the ordinary sense there will be no vacation for European students in the college in the tropics, because no vacation is really needed under the conditions of life proposed, whilst the difficulties of providing for a satisfactory vacation in the ordinary sense within the island are considered to be insuperable. Suitable opportunity for recreation will be provided within the discipline of the college. Parents in England who wish their sons to take up tropical agriculture as a career will therefore be assured of a satisfactory supervision during the year of study in Ceylon. The cost of board, residence, and instruction for this year is estimated at £150, which, having regard to the longer period of the curriculum, is rather less than the cost of an agricultural college at home.

It is very desirable that scholarships should be offered of this value to students at agricultural colleges at home, in order to render easier the special training of the most

promising of those students who wish to take up tropical agriculture. Private benefaction might well assist the scheme by providing such scholarships.

It is to be hoped that it may be possible to provide in Ceylon for the realisation of the scheme. If not, Southern India offers many advantages, and there are some who desire to see the college founded in the Federated Malay States. In dealing with the question in detail, it is important that certain facts should be kept very clearly in view.

The college should be Imperial in its educational character, and open to properly qualified candidates from all parts of the Empire, without distinction of race.

The college will provide a training and experience in tropical agriculture for those who are already qualified in general agricultural principles and in the sciences connected with agriculture, as evidenced by the possession of the diploma of any recognised college or university.

The Imperial College, while having close relations with the Government Department of Agriculture in the country in which it is established, should, as an educational institution, be separately organised under the management of a Committee on which all agricultural interests are represented, with a representative governing body in London.

The college should not trench on the domain of local colleges and schools engaging in elementary teaching, but should be a place of advanced learning and research for those who have already received a general agricultural education.

In founding a college to fulfil such important purposes, so closely connected with agricultural advancement, it is hoped that the Governments of the tropical countries will participate, and, having regard to the great national interests affected, it may reasonably be hoped that the Government of this country will give the scheme, when complete, its financial support. The National Exchequer has responded not illiberally to demands for financial assistance for closely allied subjects, such as the advancement of tropical medicine, and it has assisted in the formation of an Imperial Bureau of Entomology.

Closely connected with, though distinct from, the establishment of such a college on satisfactory educational lines is the provision of suitable accommodation for European students, and of a proper discipline during their residence in the tropics. In the first instance, at all events, the large majority of the students will be young Europeans who will be new to life in the tropics, and who will need at least as much care, attention, and discipline as they receive in a college or university at home. The question of the erection of hostels or boarding-houses and their management is one for consideration apart from the establishment of the college. Whilst the duty of erecting and establishing the college is one which should devolve principally on the Governments of the countries concerned, and partly on the planting companies and firms interested, it seems desirable that the hostel for European students, though subject to the Board of Management of the college, should be endowed by separate European subscription.

The establishment of an Imperial College of Tropical Agriculture is to be considered at this Congress, and it is hoped that as a result further co-operation will be secured for a project which is of vital importance.

A British Institute of Tropical Agriculture

In dealing with the question of proper provision for technical education in tropical agriculture, as well as in considering other matters of importance to the subject, advance is retarded by the absence of any unofficial society or institution in this country which can claim authority to speak in the interests of British tropical agriculture, and represent the opinions and promote the interests of those who are engaged in what ought to be regarded as an honourable profession. The matter is outside the sphere of any Government Institution, and the International Association for Tropical Agriculture, by reason of its constitution, obviously cannot assume these duties; in fact, British relations with the Association are hindered by the absence of any British society of the kind. Surely the time has come for the formation of a society comprising

all interests in a subject which is so profoundly connected with the welfare of the Empire.

I desire to submit to the British Section of the Association for its consideration, and for such action as it may consider expedient to take, the question as to whether it is not desirable to proceed to form a British Institute of Tropical Agriculture, whose functions would include the holding of meetings for the reading of papers, the discussion of all matters concerning tropical agriculture, and the consideration of education and qualification for the profession, and, in fact, doing whatever it may consider desirable to promote the interests of the subject of tropical agriculture, and of those who are engaged in it. My own experience in the period of twenty years during which I have been closely in touch with the subject, and with those who are working for it in all parts of the world, has led me to the conclusion that action in this direction is much needed, and that the establishment in this country of such an institute on the lines of those of other professional bodies, such as the Institutions of Civil, Mechanical, and Electrical Engineers and the Institute of Chemistry, and many others, would be welcomed by all those who, as specialists, planters, merchants, or manufacturers, are connected with the subject of agricultural production in the British tropics.

A British institute of the character indicated would, of course, be affiliated with the various agricultural societies in the British tropics and with the International Association, and would, with great advantage, take over the work at present performed by the British Committee of the Association.

The best methods by which those countries which are connected with the International Association can co-operate in its work and strengthen its action are to be considered at a meeting of the members of the Association at the close of this Congress. I feel satisfied that the large work which lies before the International Association will be best promoted by a scheme involving the affiliation and close co-operation of a society or institution in each of the European

countries interested in the advancement of tropical agriculture, and our Continental colleagues have expressed the wish that this opportunity should be taken to elicit the views of the British members on this important subject.

Government Departments of Agriculture

The organisation of Government Departments of Agriculture is a subject of much importance, intimately connected with that of technical education. I referred to some of its aspects in a Presidential address to the Section of Chemistry and Agriculture at the meeting of the British Association in 1906. It must be admitted that generally in the British tropics the organisation of Agricultural Departments is still primitive and wanting in principle. Owing to causes to which I have alluded, it is not easy to find a supply of men educated and otherwise qualified to fill official positions of authority in the subject.

It is now recognised that the Director of a Government Agricultural Department in the tropics, or, as he is more usually called, although with some risk of misunderstanding, the Director of Agriculture, should be a man of experience in the practice of tropical agriculture, with such a knowledge of the sciences on which the practice of agriculture depends as will enable him to understand when and how to call to his assistance the members of his staff who are specialists in those sciences. He must also possess administrative ability and the power of organisation. Without this link in the Head of the Department between the scientific staff and the practical agriculturists of the country, whether native or European, the Department will lack effectiveness. A mere assemblage of specialists without a leader versed in agriculture will fail to effect that influence on the advancement of the agriculture of a country which is one of the most essential and at the same time one of the most difficult functions of a Government Department. It sometimes happens that a specialist, it may be a botanist, a chemist, or an entomologist, has sufficient interest in agricultural practice to

make it his study, and if he also possesses other qualifications he becomes a distinguished Director of Agriculture. There are several examples in the British Colonies of such men who have done and are doing eminent service for the advancement of agriculture in their respective countries. These, however, are brilliant exceptions to the rule that a definite system of educating and training tropical agriculturists is better than a want of system in which the right man may eventually emerge by chance. Much the same state of affairs which exists in British countries has until lately been the rule in other parts of the tropics. It is clear, however, that everywhere the movement is now towards a more systematic plan which only needs the provision, through the establishment of a Central College, of the means of technical education in order to secure its general adoption.

The problem of securing as head of an Agricultural Department a man with a broad outlook as well as administrative ability has found a different solution in India. In India the head of a Provincial Department, called Director of Agriculture, is a member of the Indian Civil Service, usually without any knowledge either of agriculture or of any of the sciences on which it depends. He has complete control of the Department and of the specialist staff. He has, as second in command, an agricultural specialist with the title of Deputy Director of Agriculture, on whom must actually, though not nominally, fall the real initiative and control of the Department. The system can only be justified, or rather excused, by the real difficulty of finding trained agricultural officers with those other qualifications which are essential in the head of a Government Department in India, and by the circumstance that besides technical agriculture there are usually involved in the work of the Department purely administrative and legal questions relating to land, with which an Indian civilian is best qualified to deal. I have been in touch with this system for a number of years, and during a recent visit to India I have had further opportunities of studying it.

It must be admitted that occasionally an Indian civilian

has taken great interest in agricultural work, and has made himself an efficient and sympathetic head of the Department. In general, however, the plan has many drawbacks, and so long as it is adopted the best men will not be attracted to the Indian Agricultural Service, in spite of the pecuniary advantages which it offers as compared with the Agricultural Service of the British tropical colonies. I am imformed that it is possible for a Deputy Director of Agriculture in India to become the head of the Department. I am, however, not aware of any instance in which this has actually happened, although the Deputy Director may act as the head of the Department in the temporary absence of the Director. So far as I am aware, an actual vacancy is generally, if not invariably, filled by the appointment of a member of the Indian Civil Service.

Admitting the difficulties at the present time which stand in the way of the creation of self-contained Agricultural Departments in India, I venture to think that some change is now called for in the existing plan. If it is considered impossible to form a separate Department for dealing with administrative and legal questions connected with land tenure, I am inclined to suggest that an alternative might be found in the formation in each province of a small Board of Agriculture, composed of official and non-official members, of which an Indian civilian would be the secretary. The non-official members might well be Indians chosen on account of their interest in the subject. The Director of Agriculture, who would be responsible to this Board, would have full charge of the specialist staff, and would be directly concerned with the technical work of the Department and with the reports which it issues.

The advantages of this system would be that whilst reserving to the Board the consideration of general questions, including those relating to land tenure, the Agricultural Officer would receive his proper title of Director of the Department, and would have the direct charge of the whole of its technical work, and be directly responsible to the Board, whose meetings he would attend.

The Government would still have the advantage of the administrative experience in other than technical questions

of the Secretary and the members of the Board, the Secretary being an Indian civilian with a title—Secretary to the Board of Agriculture—more in accordance with his proper duties.

The inclusion of Indian members in the Board would have the great advantage of securing their interest and co-operation in the agricultural advancement of India, which is so much to be desired.

It is almost a truism that investigation and research should be vital parts of the work of Government Agricultural Departments. The fact that so little is being done in the tropics makes it, however, necessary to consider the question, which is to be discussed at one of our meetings. By research in this connection is not meant the trials and plot experiments which form part of the regular routine work of an Agricultural Department, but the attack and concentration on definite problems by qualified specialists. The reports issued by the various Departments of Agriculture in the tropics, British and other, show that, in general, scientific investigation is not definitely provided for, and that the energies of the usually small staff are being entirely occupied with routine work. It is not every one who is inclined or qualified to deal with the larger questions which await solution as the result of systematic experiment in tropical agriculture, but where such men exist, and they should exist in all Departments, the necessary facilities and assistance should be provided. It will no doubt be said that this involves additional expense, but it is expense which it is well worth while to incur in the interests of the countries concerned.

The amount of expenditure in connection with Government Agricultural Departments in the British tropical colonies, though greater than it was, is still very small in relation to their importance, and to the large amount of valuable work that is being done.

In India the College for Higher Instruction and Research, established at Pusa in Bengal, is now entirely devoted to research on questions of general importance to India. The Central Research Institute, as it is now called, is performing work of great value to Indian agriculture as

a whole. At the same time, its efforts should not lead India to overlook the fact that, with the great diversity of conditions which prevail throughout that great continent, research is also called for in each of the Provincial Departments of Agriculture, where scientific investigation should be chiefly directed to problems of local importance. The results of investigations conducted in one district of Bengal often require re-investigation in their relation to different conditions in other places. The Research Institute at Pusa cannot in any case be expected to deal with all the agricultural research which is called for throughout India, and the prosperity of the Provincial Departments of Agriculture is intimately connected with the power which is given to them of acquiring new knowledge with special reference to problems of local importance.

The International Congress and the International Association

The deliberations of the Congress are to extend to a large number of important subjects relating to the various aspects of tropical agriculture and industries. It will be within the province of the meetings of the Congress to recommend the appointment of Special Committees to collect information on any subject in which it may be considered useful to take action with a view to a report being presented either to the next Congress, or before that event for publication by the International Association.

I have ventured to suggest three questions of general importance for special consideration which it may be convenient to deal with in this way.

(1) The establishment of an Imperial College of Tropical Agriculture, (2) the formation of a British Institute of Tropical Agriculture, which more particularly concerns the British section of the International Association, and (3) the question of the constitution of the International Association considered as a federation of Central Societies in the capitals of European countries, in communication with Agricultural Societies and Institutions in the tropics.

I may now bring this address, already, I fear, too long, to a close with an expression of the hope that the first

meeting of the Congress in the capital of the British Empire may result not only in a satisfactory interchange of views between the representatives of various nations and the advancement of several important matters of tropical agriculture, but also contribute to the formation of those personal friendships between agriculturists of different nationalities which have such a powerful influence in promoting that extension of knowledge which is our common desire.

AGRICULTURAL RESOURCES OF THE ZANZIBAR PROTECTORATE

By F. C. McClellan,

Director of Agriculture, Zanzibar

Position and Geographical Formation[1]

Zanzibar is situated between latitudes 5° 42′ S. and 6° 28′ S.; its length is 46 miles, and its breadth 20 miles. It is separated from the mainland of East Africa by a channel 20 to 30 miles wide.

The island of Pemba lies about 40 miles north of Zanzibar, and between latitudes 4° 50′ S. and 5° 30′ S., the line of longitude, 39° 45′ E., almost bisecting it longitudinally. It is about 40 miles long, with an extreme breadth between the reefs of the west and east coasts of 16 miles.

Geologically Zanzibar is composed of:

(*a*) Hard coral limestone; (*c*) Sand;

(*b*) White or yellow chalky deposits; (*d*) Red earth.

A very soft sandstone is found occasionally, and harder beach sandstone occurs at a few places near the town.

The red earth is formed by the disintegration of the coral rock, and the chalky deposits have probably a similar origin.

The land on the west of the island rises in a series of

[1] The writer is indebted for much of the information contained in this section to two papers contributed to the *Proceedings of the Cambridge Philosophical Society*, Vol. xi., Part III., and Vol. xii., Part I., by Mr. Cyril Crossland, B.A., who visited the Protectorate on the invitation of Sir Charles Eliot, K.C.M.G., H.M.'s Agent and Consul-General.

low, undulating hills to a central ridge or plateau which passes through the centre of the island from north to south, and which at its highest point does not exceed 450 ft.

The coast lands of the east and south of the island consist largely of coral rock, sharp and pointed and difficult to travel over on foot, or by donkey (the usual means of progression where metalled roads have not been constructed).

The soil on the above-mentioned plateau is a red, and in places a yellowish, marl. On the large Government plantation of Marseilles, this red marl extends to a depth of 40 ft. followed by 11 ft. of red and white sand and then 26 ft. of a yellowish marl.

Where not exposed to wind, the red marl is the soil on which clove trees do best; but there must be plenty of depth, as the clove has a tap-root system of growth.

The coral rock, when broken, is hard, crystalline, and yellowish or white.

Pockets of red or black earth are often present; and in such pockets the natives grow their Indian corn and the various millets, Sorghum, Eleusine, Setaria, Pennisetum, and mohogo, and even, in deep pockets, sugar cane. Formerly chillies were largely grown on such soil.

Pemba presents in many ways features common to Zanzibar, namely, a regular and comparatively slight erosion of the more uniformly hard rock of the east coast, and a deeper and very irregular irruption into the west coast, forming long tidal creeks, formerly very useful to the slave-dhows for hiding, now useful for carrying, on the tide, articles of commerce to the heart of the island, and bringing out cloves and copra.

The coral outcrop in Pemba is confined to a strip on the east coast, and to the three northern promontories.

The proportion of land suitable for cultivation is much larger than in Zanzibar.

The island, except for a flat strip following the line of coral outcrop, consists of a series of hills and valleys; the latter mostly swampy in the rainy weather.

The clove-tree grown on the hill-sides, and sheltered

from winds, meets with its true environment in Pemba; and the plantations there are as a rule heavier bearers than those in Zanzibar—age for age.

While Zanzibar is an enlarged portion of the barrier roof of the mainland coast, Pemba is an independent formation.

Climate

Rainfall

The early rainfall records are unreliable, but measurements taken from 1874 to 1878, in the town of Zanzibar, show an average of 61 in. per annum. In the five years 1880 to 1884 the average annual fall in the town was 48·8 in., and in 1892 to 1896, 55·29 in. Pemba has a much heavier rainfall than Zanzibar, and the centre of the island has a heavier fall than the north. No records are available for the south.

The figures for 1899 are:

		Inches.	No. of rainy days.
Zanzibar island:	Town	66·69	144
" "	Dunga	97·94	183
Pemba island:	Weti	96·69	147
" "	Banani	105·24	149

The figures in inches for later years are as follows:

	1908.	1909.	1910.	1911.	1912.	1913.
Zanzibar Town . .	53·62	85·14	50·00	59·14	67·91	53·09
Pemba (Banani) . .	61·33	79·03	83·00	83·40	57·91	86·89

The fear expressed in the seventies that the rainfall was decreasing was no doubt partly due to the unreliability of the earlier figures, and is not borne out by recent figures.

The rainy seasons are well defined. The heavy rains occur in April and May previous to the setting in of the S.W. monsoon. The light rains occur in November and December previous to the setting in of the N.E. monsoon. Some lighter rains, eagerly looked for by the small agriculturist, occur in July.

The planting season for the clove tree and coconut tree in Zanzibar is during the light rains occurring just

previous to the Masika, or heavy rains, and in Pemba in the showery weather following the Masika.

Temperature

The mean temperature in the five years 1874–8 was 80·3° F., and the average yearly range from the highest maximum to the lowest minimum 17·3°. In 1880–4 the average mean temperature was 79·3° with an average yearly range of 23·8°. The average figures for recent years are given in the following table:

Year.	Zanzibar.		Pemba.	
	Maximum.	Minimum.	Maximum.	Minimum.
1909	84·9°	75·9°	81·2°	69·6°
1910	84·4°	76·4°	80·9°	69·7°
1911	84·3°	76·3°	81·8°	70·0°
1912	85·2°	76·6°	81·6°	70·3°
1913	84·9°	76·4°	81·4°	69·8°
Average for 5 years	84·7°	76·3°	81·4°	69·8°

Area and Population

The Sultan's Dominions were originally of very large extent, though the limits of actual sovereignty depended on the martial prowess of the individual Sultan of the day; and all were governed from Muscat.

In 1856 Muscat and Zanzibar became separate Sultanates. In 1890 a part of the coast-line was ceded to Germany, and in 1904 another part to Italy. The other mainland possessions are now leased to the administration of the East Africa Protectorate.

The commercial history of the two islands is closely connected with that of the slave-trade. The status of slavery ceased to be recognised in 1897, and from that date the prosperity of the Arab land-owners has steadily decreased and their properties deteriorated.

The total area of Zanzibar may be taken as 400,000 acres, of which a large proportion is coral outcrop, covered with low bush or grass. The area of Pemba is about 245,000 acres.

According to the census taken in 1910, Zanzibar island had 114,069 inhabitants, and Pemba 85,000.

Zanzibar Town—included in the above figure of 114,069—has about 35,000 inhabitants; and the two chief townships of Pemba, Chaki Chaki and Weti, have 2,000 and 1,000 respectively. Zanzibar island has 175 people to the square mile, and Pemba 219.

Of the Pemba total 72,000 are Swahilis (including freed slaves of various mainland tribes), 10,000 Arabs, and the remainder Indians and others.

The abolition of slavery was followed by a very great increase in venereal disease, consequent on sudden freedom being given to people, especially women, who had been accustomed to strict restraint. The freed-slave class are therefore on this account, and for other reasons, bad breeders, and as a class are decreasing rapidly.

The Arabs having with their slaves lost their former prosperity, and in consequence the frequent intercourse with Muscat and the importation of fresh blood being much less than heretofore, have as a class lost much of their old mental stamina; they do not accommodate themselves to the new conditions of labour, and their days as the leading agricultural community are numbered. It yet remains to be seen who will replace them.

A large number of natives, who were there prior to the Arab conquest, inhabit both islands. In Zanzibar they are called Wahadimu, and in Pemba Wapemba. These people in both islands occupy the less fertile coast-belts, obtaining their living by fishing and growing such crops as maize, sorghum, pigeon pea, etc., and in later years coconuts. They profess Mohammedanism, and were never enslaved by the Arabs. Since the abolition of slavery and the opening up of the islands by roads they are losing their desire for isolation, mixing more and more each year with the general population, and in time may become the chief agricultural class. These people are probably increasing in numbers, but it is difficult to be certain on this point, as the returns of births and deaths from these natives are not reliable.

Of the Indian community, the Parsees are the pro-

fessional class, the Mohammedans the trading class, the Hindoos the money-lending and artisan class; the clerks are generally Goanese.

Plantation labour is provided partly from such freed slaves as live on the land, and partly from the mainland.

The freed slave has become more or less of a parasite on the land-owner. He can never get out of his head the idea, ingrained in it at the time that he received his freedom, that the Government which gave him his freedom, taking away at the same time the sources of his food and living, was bound to provide for him for the rest of his life, and he does not willingly respond to any call to work, regarding it as an injustice. Similarly he objects to pay any ground rent for the land he squats on.

The light plantation work is done more or less unwillingly by the freed female slaves, the males doing nothing; but cultivation as a rule is done almost entirely by mainland natives—generally of the Wanyamwezi and Wakikuyu tribes—who come over in increasing numbers each year, attracted by the rates of pay, which are higher than those prevailing on the mainland.

The clove harvest is almost entirely dependent on the Wahadimu and Wapemba, who each year come more and more into the field. Up to 1904 the former people hardly picked at all, remaining in their coastal villages throughout the harvest. In 1911, however, about 10,000 went up from Zanzibar to Pemba, and in 1913 about 15,000; in the latter year over 11,000 received free passes in the Government steamers. The Wapemba, who up to 1907 had resolutely held aloof from the clove harvest, are also each year responding more rapidly to the requirements, especially now that, coming into touch with town life and shops, their aloofness is conquered by a desire to get money to buy the things which they see. In a good harvest an energetic picker can earn Rs. 2 a day.

As regards labour for the two crops now grown—cloves and coconuts—there is no ground for anxiety, especially as mechanical cultivation may become more general. For any large development in other directions labour would

have to be sought farther afield, or mechanical cultivation would have to be adopted.

Land Tenure and Value

Although the custom is no longer universal, plantations are still generally sold at so much a clove tree or coconut tree, small allowances being made for fruit trees and no allowance being made for the actual land whether planted or unplanted; this probably originated in the Islamic system of tenure, under which a man possessed direct ownership of trees planted by him on waste land, the soil itself remaining the property of the Government. But all these tenures are now practically freehold, just as in England, where land tenure originated in the same idea.

Excepting in the Wahadimu and Wapemba villages, where the tenure often partakes of a communal nature, the boundaries of individual properties, though not so far very clearly defined, are recognised as existing. Where confusion arises, as it often does in Arab-owned plantations, it is generally due to the Mohammedan laws of inheritance, the frequent division at death of large properties, and the inability of the principal heir to buy out the other heirs and keep the property intact.

Great care has therefore to be taken in the purchase of such properties with regard to titles and mortgages; for as regards these latter, nearly all Arab-owned properties are mortgaged up to their full value with the Indians.

It is probable that the Government will shortly commence a survey and deal with the questions of compulsory delimitation, upkeep of boundaries, and registration of titles.

Land occupied by clove trees and coconuts is valued (when that system is followed) at from Rs. 5 to Rs. 9 per clove tree and Rs. 5 to Rs. 6½ per coconut tree in plantations ranging from a good to fair condition of cultivation and health. Of recent years clove trees have decreased in value, while coconut palms have risen.

Reckoning ninety-eight clove trees and forty-eight coconut trees per acre, the value of stocked land ranges from

£33 to £59 per acre for the former, and from £16 to £21 for the latter.

Labour and Rate of Wages

The rate of wages has increased considerably in recent years, as is natural, consequent on public works being undertaken. It is interesting to note that on a plantation on which we now keep a gang of 35 Wanyamwezi to do the necessary hand cultivation the former owner had 500 slaves, and undoubtedly in slave-days the clove plantations were much better kept. They were laid out with the greatest accuracy, and normality was preserved by a strict planting up of all gaps.

After the freeing of the slaves an arrangement was made by the Sultan on the royal plantations, under which the freed slaves worked three days a week on the land in return for being allowed to live on it and cultivate a plot.

Of recent years, however, since the Government took over the Sultan's plantations, owing to the indifferent work of these people, mainlanders have been almost entirely employed, the freed slaves being allowed to live rent free if old or sick, or if they pick cloves at harvest-time.

The Arabs have been foolish in their treatment of this question, and there is a probability that many freed slaves will obtain squatting rights on their former master's land.

In the early nineties some imported Chinese and Indian labour was tried on the Government plantations, but the labourers frequently got fever.

An attempt to import Indian settlers in 1912 was also a failure; but this was probably due to the men being selected from a wrong district.

The Wanyamwezi and Wakikuyu stand the climate well, the former having more stamina.

In 1897 women received Rs. 6 per month and men Rs. 8, both including food money, which in those days would be about Rs. 2 a month. They worked by the day, and the records do not show the cost per acre of cultivation.

Clove-picking was done at the rate of 3 pice a pishi of green cloves, equivalent (*vide* Lyne, *Annual Report*, 1898) to R. 1, pice 13 per frasila of 35 lb. of dry cloves,[1] and this

[1] 4 pice = 1 anna. 16 annas = R. 1. Rs. 15 = £1.

price was maintained through the harvest. Now the price commences on the Government plantations at 4 pice, rising to 6, and on Arab plantations at 4 or 5 pice, rising to 10 or 12 pice a pishi. These latter prices are due to want of foresight and indolence in engaging labour beforehand, so that to get his crop gathered the Arab has to attract his neighbour's labour by outbidding him.

The cultivation of plantations consists of hand-hoeing, and is done almost entirely by task-work, the unit of measurement both in clove and coconut plantations being the planting distance of clove trees, or 21 ft.

A space 21 ft. by 21 ft. is called a pengele, and on the Government plantations a labourer draws Rs. 12 a month of twenty-six working days, his daily task being 7 pengeles, equivalent to about Rs. 6½ per acre. On Arab plantations the task is 6 or 5 pengeles only, equivalent to Rs. 7½ and Rs. 9 per acre respectively.

In Pemba the Government men receive R. 1 for 16 pengeles weeded, which works out also at about Rs. 6½ per acre.

Crops

Cloves

Cloves take the first place, providing a chief source of revenue to the Government and the principal source of the Arabs' former prosperity. They were introduced about 1818, a few seeds being brought from Réunion. By 1860 there was an annual output of 200,000 frasilas—a wonderful tribute to the foresight of the Sultans and the industry of the Arab land-owners. As has been pointed out by Mr. R. N. Lyne, by concentrating their energies on cloves the Arabs became specialists in the cultivation of the tree; their slaves became expert in its planting and in the harvesting of the crop; a community of local merchants settled in the country who are an integral part of the industry, financing, in the absence of co-operative credit, every plantation-owner; and Zanzibar and Pemba, as the producers of over 90 per cent. of the world's cloves possess an importance which would never have been theirs had the Arabs listened to European advice, and substituted the cultivation of other crops for that of cloves.

In 1872 the industry in Zanzibar island was affected by a hurricane which practically destroyed the plantations, but Pemba escaped. The Zanzibar plantations were at once replanted, and therefore date from 1872, whilst many of those in Pemba are 80—90 years old.

The climatic conditions of the islands are peculiarly suited to the clove tree.

The annual market requirements are over 400,000 frasilas, and there is a slight but steady increase in the demand.

The following table shows the exports of Zanzibar cloves, expressed in thousands of pounds, during the period 1903–13 :

Year.	Destination.			
	Europe.	America.	Asia.	Africa.
1903	3,551	852	7,560	126
1904	7,312	2,056	4,839	94
1905	5,673	1,769	7,810	59
1906	8,939	717	5,328	92
1907	9,601	1,102	6,553	100
1908	7,197	651	7,050	74
1909	10,638	2,364	7,165	97
1910	4,800	1,096	6,758	128
1911	7,844	3,510	8,706	199
1912	6,067	2,576	6,539	68
1913	8,789	1,975	6,772	275

The harvest may commence as early as July, and may continue as late as March. Seasonal yields are therefore calculated from the deliveries at the Customs (where a 2½ per cent. export duty is levied) from July 1 of one year to June 30 of the following year. The following table gives the seasonal yields of the past 10 years :

Season.	Zanzibar.	Pemba.	Total.
	frasilas.[1]	*frasilas*.[1]	*frasilas*.[1]
1904–05	81,313	584,208	665,521
1905–06	78,435	130,635	309,070
1906–07	63,004	203,496	266,500
1907–08	213,662	541,993	755,655
1908–09	65,727	449,691	615,418
1909–10	109,678	300,047	409,725
1910–11	50,196	139,307	189,503
1911–12	216,507	582,153	798,660
1912–13	31,018	104,368	135,386
1913–14[2]	135,399	591,222	726,621

[1] 1 *frasila* = 35 *lb.*

[2] *To end of March.*

There being no agricultural survey and no system of agricultural returns, the area under cloves can only be approximately estimated. Pemba has rather more than two-thirds of the total clove area, with 35,000 to 49,000 acres, and there are in both islands probably between five and six million trees in bearing. The Arabs have long since ceased to raise new plantations, and the area of young woods of 1 to 10 years old is small, a matter which is receiving the special attention of the Government.

Owing to want of experiments, the age at which the clove tree gives its greatest financial return is not known; but it is probably between the thirtieth and fortieth years. In the plantations planted 21 ft. square it is necessary to remove every other tree at about the fortieth year. In Pemba the older woods, from want of thinning, have passed into the pole-forest stage, and will be useful only for shelter-woods for forming new plantings.

Yield experiments also have not been made, and such figures as are available do not indicate very accurately the bearing properties of the trees. A plantation in Pemba of about 4,000 trees, and under efficient white management, yielded in 1913 (a heavy crop year) 20 lb. of dry cloves per tree—the actual crop on trees in bearing being about 35 lb. This plantation bears an average yearly crop of 8 lb. per tree. In the same season trees 10 years old yielded 1¼ lb. of dry cloves per tree. Many of the largest trees in Pemba will, in a good year, yield 60 to 70 lb. of dry cloves per tree. A good crop is obtained once every three to five years, and the average yield of the Arab-owned plantations is about 3½ to 4 lb. of dry cloves per tree per annum.

Apart from the peculiar climatic conditions of these islands, which apparently are very suitable to it, the clove tree requires a deep, well-drained soil, shelter from wind, and ample space. Though shade is desirable when young, full exposure to the sun is necessary for fruiting. On the hill-sides of sheltered valleys in Pemba it is more at home than on the more level ground of Zanzibar.

The tree is comparatively free from disease. A leaf-

blotch which is present is caused, according to a Kew Report, by a harmless lichen. A parasitic alga, *Cephaleuros mycoidea*, Karsten (= *Mycoidea parasitica*, Cunningham), which, according to Ridley, occurs on the clove tree in Penang, has not yet been noticed here. Damage has been observed which may be due to a root-fungus, and specimens are now in England under investigation. A previously undescribed species of fungus of the genus Sphaerella was found at Kew on leaves sent home for examination, and was named *S. vexans*, Massee. The extent of damage caused by this is under investigation.

A Consular Report of 1892 mentions a leaf-eating caterpillar, but no noticeable harm is done by it. Coccids are stated by Ridley to attack cloves in Penang, but no evident damage from this cause occurs here.

A species of Loranthus is met with on most trees in Zanzibar, but has so far not been recorded in Pemba. It is seen especially on those of the citrus family, and is common in neglected clove shambas, as is also the dodder-like Cassytha. Various epiphytic growths occur on all the trees under conditions of old age and unsuitability of locality.

Provided proper attention is paid to the natural requirements of the tree and to its cultivation, the clove tree is more free from insect and fungoid attack than most trees, but, as in the case of all exotic trees, a careful and continuous scrutiny is necessary.

The cloves are gathered by hand, the pickers climbing the trees and drawing the branches towards them by hooked sticks. The method is wasteful, and results in much damage to the trees; but in many cases the trees are too tall for ladders to be used.

The stems are separated from the heads by hand, and the picker is paid for the stemmed cloves only, which are measured or weighed. The proportion of stems to cloves varies with the age of the tree. In a mature plantation of forty years old, 25 to 30 lb. of stems should accompany 100 lb. of cloves. But in ordinary management a much smaller proportion is obtained, as the Arab pays but little attention to them.

Drying is done either on a concrete, cement-faced drying floor, or on mats made from native palms. The former method is of course the best, and under it in fine weather drying is completed in from three to four days. Showers do not cause any harm provided the cloves are spread out on a barbecue and raked over. Drying in the sun does not cause the bud to shrivel, as has been stated; but the shrivelling so common in Zanzibar, and especially in Pemba cloves, is due to heating and careless drying.

Pemba cloves as a general rule fetch a lower price in the local market owing to careless methods of preparation, but those from two plantations which possess barbecues are finer than those from Zanzibar. Under similar conditions of age and soil, and with good management, Pemba plantations give the better results.

The Arab custom of piling the cloves in heaps during wet weather results in fermentation and blackening. Drying under glass has been tried, but with no measure of success. The tray system has been used and abandoned on account of the expense. A hot-air drier was erected by one plantation owner, but in the following year he reverted to the use of his barbecue. Samples of these artificially dried cloves have been examined at the Imperial Institute and an account of the results of their examination was given in this BULLETIN (1912, **10**, 574).

Samples of cloves, stems, and fruits (mother of cloves) were examined this year, and these are dealt with on p. 337. An account of the results of examination of a sample of clove-leaf oil will be found in this BULLETIN (1913, **11**, 438).

One hundred pounds of green cloves will yield about 47½ lb. of dry cloves.

There are at present considerable fluctuations in the price of cloves, and there is much speculation in this spice. The average local price per frasila for the past few years is given in the accompanying table. It is interesting to note that the average price for the three years 1895 to 1897 inclusive was Rs. 4·57 for Zanzibar and Rs. 4·23 for Pemba cloves.

Year.	Zanzibar cloves.	Pemba cloves.	Stems.
	R. *a.* *p.*	*R.* *a.* *p.*	*R.* *a.* *p.*
1907	10 3 6	9 9 0	2 6 0
1908	9 2 0	8 8 0	2 6 0
1909	8 8 9	8 3 6	2 0 9
1910	11 4 3	10 15 3	3 0 0
1911	12 5 3	10 3 6	3 0 9
1912	14 5 0	13 8 3	3 14 9
1913	14 5 3	14 5 3	4 5 9
1914	11 5 6	10 15 0	3 2 6

Coconuts

The coconut comes next in order of precedence, though its importance is of modern origin. The Arabs planted some near their houses for purposes of food, and allowed the slaves, similarly, to plant a few outside their huts. Only rarely are systematically laid out plantations met with.

Of late years planting has been much on the increase, but the method and precision found in the Arab clove-plantings is absent from their coconut fields. Many of the Wahadimu and Wapemba villages consist of coconut groves with the huts beneath.

In the absence of agricultural returns only a rough estimate can be given of the number of trees in the two islands, but there are probably about 2,500,000 covering an area of about 45,000 acres.

Under white supervision the tree yields 80 or 90 nuts per annum on good soil. In the inland plantations the yield is less and the trees come into bearing later.

Five varieties of nuts are recognised, three named according to their colour—white, black, and red—and two varieties of Pemba coconut. No experiments have been carried out with regard to these, but the red variety is regarded as the earliest yielder. Of the Pemba varieties, one is used only for its milk, which is exceedingly pleasant to drink, while the other is used both for copra and its milk.

Given proper cultivation and attention, the coconut tree is much freer from disease in Zanzibar than in many other countries. The rhinoceros beetle occurs here as elsewhere, but its ravages are slight as compared with those reported from other coconut-producing countries. Bud-rot is notice-

able in neglected woods, but where disease is most evident it will be found that the owner does not clean his land, spending what money he can spare on trying to clean his clove-area.

Zanzibar copra is not of very good quality. Its price at present compares unfavourably with that of Cochin and Ceylon copra, but this is entirely due to want of care in its preparation, and to the producer's lack of capital. Samples prepared on the Government plantations have been most favourably reported on. The following extracts are taken from the broker's report:

"Ten bags mentioned as 'sun-dried copra' . . . is a very fine shipment of sun-dried copra and much better than copra sold under the ordinary guarantee of 'fair merchantable sun-dried.' . . . It compares with copra shipped from the Malabar Coast."

The copra is either sun-dried or smoke-dried, the latter process yielding a black product of very inferior quality.

The mean annual output of copra from the two islands for the ten years ending 1912 was 16,000,000 lb. The exports in recent years are shown in the following table:

Year.	*Tons.*	*Year.*	*Tons.*
1904	3,228	1909	3,393
1905	4,718	1910	3,932
1906	4,537	1911	8,110
1907	4,122	1912	7,443
1908	4,654	1913	7,412

The export trade is in the hands of two or three firms, and most of the copra goes to Marseilles.

In addition to the nuts used for the production of copra, large numbers of coconuts are used for food, each native taking at least two a day, and often more, for that purpose.

A certain amount of coconut oil is manufactured in the islands. The values of the combined exports of this oil and of sim-sim (sesamum) oil in recent years are shown in the following table:

Year.	*Value in Rupees.*	*Year.*	*Value in Rupees.*
1904	49,492	1909	32,662
1905	61,543	1910	30,902
1906	46,860	1911	54,673
1907	67,423	1912	49,159
1908	10,280	1913	35,918

Fettered by want of capital, the plantation owners neglect coir fibre entirely, and there are no exports of this. Matting and rope of excellent quality are made in the town jail from home-produced coir, and samples of these are now on view in the Public Exhibition Galleries of the Imperial Institute. A small consignment of matting and rope was recently sold in London, and samples have been examined at the Imperial Institute (see p. 350).

Speaking generally, the conditions of both islands are very favourable to coconut cultivation, and considerable areas of unplanted land await capital for their development.

Rubber

Two rubber-producing plants are indigenous, *Landolphia Kirkii* and *Mascarenhasia elastica*. The rubber exported is obtained almost entirely from the former, which occurs in a small forest in Pemba and in isolated woodland patches.

The Government planted a considerable area with Ceara rubber trees in 1907 in the north of Pemba, but the cultivation has been discontinued, and no yield experiments have been made. The trees were healthy, but the difficulties of labour and supervision in the extreme north of Pemba, where there are no roads, were such as to make further expenditure undesirable.

Samples of Para, Castilloa, and Mascarenhasia rubbers from Zanzibar were examined at the Imperial Institute some years ago and the results of their examination have been published in *Selected Reports from the Scientific and Technical Department, Imperial Institute, Part IV.—Rubber and Guttapercha* ([Cd. 6,022], 1912, pp. 272, 300, 405).

Specimens of the rubbers may be seen in the Public Exhibition Galleries of the Imperial Institute.

The following table shows the exports of Zanzibar rubber during the last ten years:

Year.	Quantity. *lb.*	Year.	Quantity. *lb.*
1904	1,733	1909	2,740
1905	362	1910	4,124
1906	2,995	1911	4,285
1907	988	1912	3,588
1908	1,334	1913	2,220

Copal

At the present time copal is not collected in Zanzibar. It is still to be found there, but the native finds that other work brings him in more money, and the exports of the local product have declined and finally disappeared. Considerable quantities are still shipped from the island, but this consists entirely of material obtained in German East Africa. The amount produced in the latter country, however, has decreased considerably in recent years. In 1888–9 the exports from German East Africa amounted to 652,664 lb. with a value of £27,321. In more recent years the exports have been as follows:

Year.	Amount. lb.	Value. £
1908	266,265	6,926
1909	317,979	7,578
1910	245,449	7,446
1911	209,937	5,369
1912	237,791	5,985

One exporting firm attributes the decline in the German East Africa exports to the exhaustion of the fossil deposits and to the lowness of the price caused by the competition of New Zealand copal (kauri resin), which has been in the market at much lower prices. This firm states that in American markets the demand for East African copal has been killed entirely by the New Zealand product. H.M. Consul at Dar-es-Salaam states that owing to the fall in the price of tree copal (fresh copal) which has constituted the bulk of the exports in recent years, the natives find that it pays them better to work on European or their own plantations. The German report on trade for 1911 states that there is no proof of the correctness of the statement that the deposits of fossil copal are being worked out, but on the other hand the Report for the whole Protectorate states the decline is due to that cause.

The total exports of copal from Zanzibar in recent years are shown in the following table:

Year.	Quantity. lb.	Year.	Quantity. lb.
1904	277,826	1909	263,204
1905	227,704	1910	216,671
1906	256,435	1911	169,261
1907	223,305	1912	213,637
1908	262,184	1913	164,159

Chillies

Chillies were at one time cultivated to a considerable extent by the Wahadimu who occupy the coral strip of the eastern coast of Zanzibar, but the industry has declined in recent years. The quality, when the chillies are properly prepared for market, is extremely good, and in strength and palatability the Zanzibar product is superior to the Japanese, though it is not so bright in colour.

The decline in price, apart from ordinary trade fluctuations, is due to the carelessness of the natives in picking and harvesting, combined with dishonest or improper methods adopted by the town buyer. In 1899 the Government brokers reported very favourably on those sent from the Government plantations, and prepared with ordinary care only.

The exports of chillies have declined recently, as is shown in the following table; but the decline in later years is partly due to the fact that the growers now take a chief part in the clove-harvest.

Year.	Weight. *lb.*	Value. £	Year.	Weight. *lb.*	Value. £
1904 . .	428,881	5,837	1909 . .	103,231	1,304
1905 . .	500,509	4,951	1910 . .	184,383	2,192
1906 . .	290,621	1,877	1911 . .	92,625	1,414
1907 . .	13,627	45	1912 . .	104,720	1,381
1908 . .	30,129	256	1913 . .	76,513	1,042

Cocoa

There is no export of cocoa, and the only planting of any importance was made on the Government Experimental Station in 1898 with seed obtained from Seychelles. The experiments were abandoned by the Government in 1909, and the cultivation has not since been proceeded with. Most of the bushes have disappeared, but the few still remaining are healthy.

The sheltered valleys and humid atmosphere of Pemba are very suitable to cocoa, and capital only is required to make it a valuable adjunct to the agricultural crops of that island.

Sugar

In slave days sugar was largely cultivated by the Arabs, and ruined sugar mills are commonly met with in the Arab-cultivated districts. The industry was at its zenith under Seyyid Barghash in the sixties, and in 1864 £3,000 worth is said to have been shipped from the plantation known as Fraser's shamba. Various causes have contributed to the decay of the industry, chief amongst which was the Arab's labour difficulty on the freeing of his slaves.

Vanilla

In 1897 the Government commenced the cultivation of vanilla with a view to encouraging the Arabs and small native land-owners to grow it; and about 10,000 plants were established at Dunga. The plantations were healthy, and the brokers' report satisfactory, the value of the consignments ranging from 6*s.* to 12*s.* per lb. After twelve years' trial, the Government discontinued the cultivation, as the Arabs and natives would not take it up, and a few Seychelles people are now the only growers.

The last consignment was sent home in 1908 and included some vanilla valued by the brokers at 7*s.* to 8*s.* per lb., and some of inferior quality valued as low as 3*s.* 6*d.* per lb.

Fibres

All the principal fibre-producing plants of the tropics have been grown on the Government Experimental Station at Dunga, but no trials on a commercial scale were carried out. Much of the coral outcrop land of Zanzibar, which comprises about three-fifths of the island, is well adapted for Sisal hemp, and there are some plains in the north-central part of the island which are also suitable, and where the difficulties of cultivation would be less.

Samples of fibres produced experimentally in Zanzibar are now on view in the Public Exhibition Galleries of the Imperial Institute.

Kola

This grows well and is easily raised. Consignments are sent home each year from the Government plantation, and fetch from 4½*d.* to 5*d.* per lb.

Minor Products

In another section of this BULLETIN (pp. 340-350) will be found reports by the Imperial Institute on various minor products grown in Zanzibar and Pemba and sent for examination. It should be pointed out that the Government closed its Experimental Station in 1909, and the products now reported on were obtained from native growers and without selection. With few exceptions the products referred to are not exported, but are only grown for local consumption. In a number of cases the quantity grown is insufficient to meet the local demand and considerable amounts are imported, as is indicated in the following table:

IMPORTS OF AGRICULTURAL PRODUCE, TIMBER, AND STOCK

Value in hundreds of rupees

Year.	Rice.	Maize.	Sugar.	Tobacco.	Timber.	Cattle.	Goats and sheep.
1904	85	50	1,123	719	199	1,277	1,386
1905	1,104	182	1,285	1,008	852	1,322	1,251
1906	1,491	190	1,473	893	1,016	1,304	1,019
1907	2,825	308	1,578	1,455	729	1,324	1,361
1908	22,221	217	2,471	1,220	904	1,622	1,565
1909	18,769	247	3,441	894	864	1,706	1,382
1910	16,441	152	3,552	1,253	272	1,452	1,409
1911	20,764	212	3,620	1,051	839	1,720	1,570
1912	26,106	267	4,399	1,477	911	1,932	1,779
1913	22,903	266	4,136	1,829	1,033	1,326	1,139

Cassava is the principal food of the native and is only grown where there are native huts. Both the sweet and bitter kinds are cultivated, and the native recognises under local names many varieties, of which one is pre-eminent.

Several varieties of hill and valley rice are cultivated. Rice forms one of the staple articles of food of the Indians, Arabs, and natives, and is now grown by the last-mentioned in small patches only. A number of samples of unhusked

rice from Pemba were examined at the Imperial Institute last year. Specimens which had been husked at the Imperial Institute were submitted to two firms of merchants in London, who reported favourably on them and valued them at 10*s.* to 10*s.* 6*d.* per cwt. in London (see this BULLETIN, 1914, **12**, 102).

Maize is grown locally by the natives for food, and several varieties are recognised under native names.

Sorghum vulgare is largely cultivated by the Wahadimu and Wapemba for food. Varieties of Eleusine, Setaria, and Pennisetum are cultivated also by the same classes for food, especially in the coral out-crop districts where they principally live. Specimens of these millets grown in Zanzibar have been examined at the Imperial Institute (see p. 340).

Vigna Catjang, *Phaseolus Mungo*, *Dolichos Lablab*, and *Cajanus indicus* are in common cultivation by all natives for food. The results of examination of samples of these seeds from Zanzibar are given on p. 342.

The ground nut (*Arachis hypogaea*) and the Bambarra ground nut (*Voandzeia subterranea*) are grown to some extent for food. For the results of examination of samples of these seeds from Zanzibar see pp. 345, 348.

Cinnamon was grown on the Government Plantation at Dunga, but its cultivation was given up when the Government abandoned the experiments at this station. Some few hundred nutmeg trees are grown on the Government plantations; these are healthy and bear well. The cultivation of ginger, like that of chillies, has fallen off. Pepper is grown occasionally.

Sim-sim (sesamum) is grown by Arabs and natives and sold to local oil-mills. The results of examination of two varieties of sim-sim from Zanzibar are given on p. 346.

Jatropha Curcas is commonly grown as a boundary plant. The oil of the seeds is used locally by natives, and the plant is employed as a support for vanilla. A sample of this seed from Zanzibar has also been examined at the Imperial Institute (see p. 347).

Moringa pterygosperma is used as a boundary for com-

pounds in villages. The oil is occasionally used by natives. A sample of moringa seed from Zanzibar has been examined at the Imperial Institute (see p. 348).

Telfairia pedata is grown by the Wahadimu in Zanzibar and the oil used by them for anointing purposes. An article dealing with these seeds, and including an account of the examination of a sample from Zanzibar, was published in a previous number of this BULLETIN (1912, **10**, 223).

The castor-oil plant is grown in patches by natives and the oil used for medicinal and anointing purposes. An account of the examination of a sample of castor seed from Zanzibar is given on p. 349.

The oil palm is indigenous, and the fruits are collected in Pemba for sale locally. The exports of oil-palm products are small and are not shown separately in the official trade returns. For the results of examination of a sample of palm nuts from Zanzibar see p. 349.

Kapok (*Eriodendron anfractuosum*) is a common boundary tree, the floss being used locally for mattresses and pillows. That produced on the Government plantations sells in the United Kingdom for 5½*d.* to 6*d.* per lb. The seeds contain an oil similar in properties to cotton-seed oil, and specimens from Zanzibar have been examined at the Imperial Institute (see p. 347).

The soap-berry tree (*Sapindus saponaria*) is cultivated by Arabs and natives on a small scale, and the berries are used for washing purposes.

Tobacco is grown locally, especially in Pemba, for chewing; for this purpose the tobacco is mixed with lime and a chip of areca nut and wrapped up in a leaf of the betel vine (*Piper Betle*). The betel vine is cultivated in Wahadimu and especially in Wapemba villages, and sold for the above purpose, 320 leaves fetching R. 1. The areca nut is common on all plantations.

Of the cultivated fruits, the oranges from trees planted by Arabs in their days of prosperity are equal to any in flavour; and this applies also to pine-apples, which are a common weed on neglected plantations, and the cultivated varieties of which are extremely fine. The

mango has become naturalised all over the two islands and abounds in neglected clove and coconut plantations. Bombay varieties originally imported by the Sultans are very good. The Otaheite apple (*Spondias dulcis*), tamarind, papaw, guava, rose-apple (*Eugenia Jambos*), custard apple, sour-sop (*Anona* sp.), date, fig, Malay apple (*Eugenia malaccensis*), sapodilla, avocado pear, litchi (*Nephelium Lit-chi*), bullock's heart (*Anona* sp.), pomelo or shaddock, mandarin and tangerine oranges, lime, sweet lime, lemon, citron, durian, jack-fruit, bread-fruit, bread-nut, cashew nut, African almond (*Terminalia* sp.), pomegranate, granadilla, etc., are all of common occurrence in Arab and native gardens.

GENERAL NOTICES RESPECTING ECONOMIC PRODUCTS AND THEIR DEVELOPMENT

THE UTILISATION OF FISH AND MARINE ANIMALS AS SOURCES OF OIL AND MANURE

PART II.—MANURE

THE first part of this article (this BULLETIN, 1914, **12**, 251), dealt with oils obtained from fish and marine animals and included an account of the present position of the whaling industry. The present part deals with the utilisation of fish and marine animals as sources of manure, with fish meal as a cattle food, and with fish glue.

For considerably over a century waste fish, in various forms, has been employed as a manure. The most primitive method of use is that of applying the fresh fish direct to the land and, after it has decomposed sufficiently, ploughing it in. This method is still employed in many localities where there is an abundance of fish unsuitable for food or when there is a glut of edible fish. Thus at Cape Spear, in Newfoundland, large quantities of capelin, a variety of sardine, annually visit the surf and are caught for use as a manure.

This method has the disadvantage that a considerable proportion of the nitrogen present in the fish is lost as

gaseous ammonia during the putrefaction, and further, the material cannot be stored profitably for future use. It is also stated that the continued use of oily fish, such as herring or sardine, in this manner has a detrimental effect on the physical condition of the soil. These, and other difficulties, led to the modern practice of making fish manure

Manufacture of Fish Manure

The manufacture of fish manure is undertaken, in many localities, merely as a means of profitably disposing of fish residues. The chief exception to this is the extensive menhaden fishery carried on along the Atlantic seaboard of the United States solely for the manufacture of oil and manure (*loc. cit.*, p. 258).

The methods used in the manufacture of fish manure and oil vary greatly in details, but speaking generally the process is carried on in three stages: (1) cooking the fish to soften the tissues and facilitate the removal of the oil; (2) pressing the cooked mass in order to remove oil and water; (3) drying the residue. The following account of the manufacture of fish manure applies especially to the menhaden industry of the United States, but the processes are applicable to the manufacture of manure from almost any kind of fish; in those, however, such as cod, dog-fish, and shark, which have the oil largely in the liver, the latter is removed and treated separately. The older methods, involving the use of open vats and either hydraulic or hand presses, can be adapted for use on a small scale, but the more modern methods, in which continuous cookers and presses are employed, are obviously only suitable for large factories.

Cooking.—In the older methods this operation is performed in open vats having a capacity ranging up to 20,000 fish (six tons), constructed of metal, wood, or cement, and having a false bottom, beneath which are steam pipes. The fish are automatically conveyed to the vats from the storage bins, and cooked, by steam, for about twenty minutes. The vapours from the cookers are sometimes led into condensing towers in order to avoid pollution of the

atmosphere by the objectionable odours produced during the operation.

The cooking must be prolonged sufficiently to render the fish easily broken, but must not be such as to cause complete disintegration, as this produces a soft, slimy mass from which it is difficult to separate the oil.

In the more modern methods the cooking is done by means of steam, in an iron cylinder which measures about 40 ft. in length and 2 ft. in diameter. Through this vessel, which is stated to be capable of dealing with about thirty tons of fish per hour, the fish are conveyed by means of a screw. The steam is admitted to the cylinder by various means, such as through hollow blades or hollow shafts of the screw conveyor or by numerous inlets in the bottom of the vessel. In this process the cooking is carried out much more rapidly than when open vats are employed.

Pressing.—In the old process the fish, when sufficiently cooked, are conveyed mechanically from the vats to the curbs of the presses, the surplus water and oil being allowed to drain away to the storage tanks of the oil room. The presses employed are mostly of the hydraulic type, although there are a few hand-operated screw presses still in use. As the pressure is gradually applied, the mixture of oil and water which drains away is caught by a sloping floor and passes to the oil room for further treatment (see p. 434). When the pressing is complete the curb is released and the pressed cake, now termed "green scrap," is discharged into the storage room below. The green scrap, which still contains about 50 per cent. of water and 6 to 9 per cent. of oil, requires to be further treated to prevent putrefaction and consequent loss of ammonia. This can be done either by drying the scrap or treating it with sulphuric acid. The older method of drying consisted in exposing the green scrap, spread on wooden or cement platforms, to the sun for about three days. As this process was entirely dependent on the weather, it has now been largely superseded by the hot-air drier described later (see p. 432).

If the scrap cannot be dried at once, or if fermentation has already started, it is spread in thin layers on platforms

and treated with a solution containing 62·5 per cent. (by weight) of sulphuric acid (oil of vitriol), about 90 lb. of the solution being used for 2,000 fish. Another process consists in heating the green scrap in "process kettles" with 5 per cent. sulphuric acid for one hour with steam at 20 lb. pressure. The acidulated scrap is either sold in the wet state for compounding with other manures or dried. Analyses of these products are given on p. 435.

In the newer continuous process, the cooked fish, together with the liberated oil and water, pass from the end of the cooker to a bucket conveyor and thence to the presses. The modern automatic continuous screw press consists of a horizontal tapered screw built on a hollow shaft and fitting closely inside a similarly tapered slatted curb. The cooked fish are fed into a hopper on top of the larger end of the press and travel forward by the rotation of the screw, being thus subjected to a gradually increasing pressure which is regulated by a cone adjustment at the smaller end of the press where the mass is ejected. The expressed mixture of water and oil drains away between the slats and is run to the oil room. It is claimed that the continuous screw press gives a product containing less water and oil than does the hydraulic press. This is a matter of considerable importance both as regards the yield of oil and the quality of the manure.

Drying.—In most of the modern factories the pressed scrap is dried in a hot-air drier. This consists of a rotating insulated iron cylinder 30 or 40 ft. long and about 6 ft. in diameter, provided inside with a series of projecting shelves 8 in. wide running the length of the cylinder. The feed, or front end of the drier, is set slightly higher than the exit end and is enclosed in a brick chamber which also constitutes the fire box. The scrap from the presses is fed into the drier and immediately comes into contact with the hottest gases from the fire box. By means of a fan the furnace gases are forced forwards, carrying with them the finer particles of the fish. The rotation of the drier and the projecting shelves in the latter cause the pressed scrap to be repeatedly taken up and scattered through the hot gases and at the same time to travel

slowly forward. Driers are also in use in which the incoming hot gases travel in the opposite direction to the wet scrap, so that the driest product comes in contact with the hottest zone of the drier. The time taken by the scrap to travel through the drier varies from 3 to 40 minutes, depending on the size of the pieces and the rate of the blower. In passing through the drier some of the smaller particles become partially burned and give rise to a most offensive odour. Attempts to prevent the pollution of the atmosphere by these gases have been made by using high chimney stacks, and by blowing the exit gases through water. The fish scrap on leaving the drier usually contains about 7 per cent. of moisture. It is conveyed to bins, where it is stored until the fishing season is over and labour is available for putting it into sacks. In the United Kingdom, the drying of the scrap is often done by means of a steam drier, especially when the scrap is to be used as cattle food. The general arrangement of steam plant is somewhat similar to the hot-air drier described above, but the heating is effected by means of a series of parallel steam pipes arranged in the form of a ring.

A method for the conversion of small quantities of fish into a fairly efficient manure may be of value to those who wish to work on a small scale without the use of special plant. A hole of suitable dimensions, say 6 by 6 by 5 ft., is dug in the ground and lined inside with clay. At the bottom is placed a layer, a few inches deep, of wood ashes, followed by a layer of fish sprinkled with lime. This succession is repeated until the hole is nearly full, and then a layer of earth is added and the hole closed by weighted boards. After being left for several months the mass is thoroughly mixed and is then ready for use as manure.

Cost of Plant.—It is somewhat difficult to estimate the total cost of the plant necessary for a fish manure and oil factory, as the situation of the works, the proposed output, and the nature of the fish to be treated largely influence the cost. The following is an approximate estimate, supplied by a well-known British firm for the

plant necessary to treat 30 tons of herring or similar fish per day:

	£
Three 1-ton cookers with agitating gear	240
„ hydraulic presses	300
„ horizontal driers (13 ft. by 6 ft. 6 in.)	1,050
One Lancashire steam boiler (30 ft. by 7 ft.)	450
One steam engine	195
Four cutting machines (two steam)	400
Two hydro-extractors	260
Six steel tip-wagons and two oil tanks	125
Grinding plant	317
Feed pump, connections between plant, shafting, goods, lift, etc.	511
	£3,848

A plant recently erected on the Pacific coast of the United States for the treatment of 100 tons per day of dog-fish, skate, mud-shark, rat-fish, and similar fish, consists of four steel cookers for fish and a similar number for livers, a hydraulic press, steam drier, triple-effect evaporator for making fish glue from the tank waters, and the necessary storage tanks. The power plant comprises two 125 horse-power tubular boilers, a 50 horse-power engine, and one 75 kilowatt electric generator. The entire plant cost £10,400, f.a.s., New York.

Several attempts have been made, in the United States, to utilise the fishing vessel as a floating factory and so save time during the fishing season. One of these vessels is a converted steel dredge of 5,000 tons, having a capacity for 5,000 barrels (446 tons) of fish. It is fitted with the usual plant used ashore, and when necessary calls by wireless telegraphy the vessels which convey the scrap and oil ashore. This floating factory has the advantage of being able to utilise fully a good shoal of fish, but some difficulty is experienced in getting an efficient separation of the water and oil.

Separation of Oil.—The mixture of oil and water, obtained from the various operations detailed above, is run into tanks in order to let the water and finely divided fish ("gurry") separate from the oil. The process is often assisted by gentle heating by means of steam coils. When separation has taken place the oil is run off and purified.

The water containing the gurry is subjected to various processes depending on whether it is desired to produce from it fish glue or a further quantity of manure. If the latter is desired, the gurry which separates out is pressed in order to get a further quantity of oil, and the pressed cake added to the scrap. At some works the aqueous liquid is evaporated to dryness in a multiple-effect evaporator, and the solid residue added to the manure already obtained. The process for the manufacture of fish glue is briefly described on p. 442.

Materials employed in the Manufacture of Fish Manure

Practically any variety of fish can be used for the manufacture of manure, but at the present time a very large proportion is obtained from the inedible menhaden (see this Bulletin, 1914, **12**, 258). Of less importance as a raw material is the waste obtained by dressing herring, cod, sardine, and other edible fish.

Menhaden.—The important constituents of several varieties of menhaden scrap are shown in the following table:

	Nitrogen. N.	Phosphoric acid. P_2O_5.	Moisture.	Oil.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Dry scrap (cargo sample) .	8·96	7·75	6·18	6·81
Sun-dried scrap (ground) .	7·81	5·85	7·46	7·89
Dried acidulated scrap .	8·00	7·52	6·30	—
Undried ,, ,, . .	5·90	4·89	45·40	—

The content of potash (K_2O) is variable, but averages 0·5 per cent. for scrap containing 10 per cent. of moisture. Estimates for the yield of manure vary to some extent, but as an average it may be taken that 15,000 fish (4·5 tons) will give one ton of dried scrap.

The production of fish manure (chiefly from menhaden) in the United States, in 1912, was 50,000 tons of dried scrap and 28,000 tons of acidulated scrap, having a total value of £416,666.

Cod.—Little manure is made from the whole fish, but

large quantities are produced in Norway from the waste resulting from the dressing of cod. As the fish contains but little oil in the flesh, it is unnecessary to submit it to any cooking process, the material being usually reduced to a fairly small size and dried first in the open air and finally in kilns. The manure, which on leaving the kilns contains about 12 per cent. of moisture, is finely ground between millstones, and is then ready for sale. Owing to the large percentage of phosphoric acid in cod heads, which constitute a large proportion of the waste, the manure is especially rich in this constituent. The percentage of nitrogen, phosphoric acid, and water in two varieties of cod manure are shown in the following table:

	Nitrogen. N.	Phosphoric acid. P_2O_5.	Water.
	Per cent.	*Per cent.*	*Per cent.*
Cod heads	6·5	20·0	3·5
,, waste	8·0	14·9	13·0

No statistics are available as to the quantity of manure made from cod in Norway, but the total production of fish manure for 1911 was 10,369 metric tons valued at £77,800.

Herring.—Large quantities of manure are made in the United Kingdom, Russia, Japan, Norway, etc., both from the whole fish and also from the waste resulting from kippering and salting herrings. The process used is similar to that employed for menhaden (see p. 430). A certain amount is also converted into meal for feeding stock (see p. 441).

The composition of some commercial brands of herring manure is shown in the following table:

Source.	Nitrogen. N.	Phosphoric acid. P_2O_5.	Lime. CaO.	Fat.	Water.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Sakhalin (i) .	10·28	6·75	6·21	5·81	9·80
,, (ii) .	10·92	4·27	2·91	6·24	10·63
Vladivostok .	11·77	4·85	4·46	11·61	6·66

Dog-fish.—As was mentioned in the previous part of this article (*loc. cit.*, p. 257), in certain parts of the world

so much damage has been done to the local fisheries by dog-fish that measures have been taken to reduce the numbers of this fish. This has been particularly the case on the North Atlantic coast of Nova Scotia, where the problem has been attacked by offering the fishermen a bounty of $4 per ton of dog-fish caught, and by establishing works for converting the dog-fish received into manure, oil, and fish glue.

Such works are in operation in Canada at Canso and Clark's Harbour in Nova Scotia, and Shippigan on Chaleur Bay, New Brunswick. It would appear, from the fact that the manure first made at these works often contained 30 per cent. of oil, that the fish were treated whole. Recently, however, the livers have been removed from the fish before the latter are cooked, and a product containing approximately the following percentages of the chief constituents is now on the market:

Nitrogen N	9
Phosphoric acid P_2O_5	4
Water	12
Oil	2

It will be noticed that in comparison with the manure made from menhaden (p. 435) that obtained from dog-fish is low in phosphoric acid. This is due to the fact that the skeletons of fish of the dog-fish class (selachians) consist of cartilage and not bone as in the case of most other fish.

Sardine.—Fish of this class are used for making manure in Japan, Madras, and elsewhere, and the refuse from the sardine canneries of Brittany is also used for this purpose. The cannery waste, consisting of heads, cartilage, and intestines, is allowed to drain, and in Brittany the liquid, which contains about 1·3 per cent. nitrogen, is used to enrich farmyard manure, about four to six barrels being applied to each acre of land.

The solid portion of the waste is converted into manure by the process already described. The yield of manure varies, but usually one ton of waste will give about 470 lb. of manure containing 10 per cent. of water. The composition of manure made from sardine offal is given in the

following table, and analyses of samples from Madras were quoted in this BULLETIN (1914, **12**, 54):

		Brittany.	Japan.
		Per cent.	*Per cent.*
Nitrogen	N	6·50	8·0 to 11·7
Phosphoric acid	P_2O_5	13·16	2·9 ,, 4·9
Potash	K_2O	—	0·16 ,, 0·76
Lime	CaO	—	2·1 ,, 4·6
Water		5·0	5·7 ,, 16·3

Salmon.—A large amount of waste results from the dressing of salmon preparatory to canning; it is stated that often one-fourth of the total salmon handled becomes waste, and in Alaska a certain proportion of this is converted into manure.

Fish Trades Waste.—The waste fish from the larger markets forms the chief source of the raw material for the manufacture of fish manure in the United Kingdom. Certain of the larger towns, where, formerly, the disposal of this waste was a difficult and expensive matter, now pay 10s. per ton for fish waste delivered at their works, but where the material has to be collected the rate of payment is much less.

The method of treatment adopted is very similar to that used for menhaden (p. 430), except that the material, before being cooked, is reduced to a standard size by means of a rotary cutter, and the superfluous water is removed by means of centrifugal machines.

In this connection it is interesting to note that the damaged fish resulting from the fish-curing industry of Sunamganj, Assam, is utilised locally as a manure for vegetables and tobacco. The constituents of manurial value in three varieties of this product are shown in the following table:

		"Chanda."	"Tangra."	"Bhera."
		Per cent.	*Per cent.*	*Per cent.*
Nitrogen	N	8·49	7·84	9·57
Phosphoric acid	P_2O_5	6·77	6·84	5·09
Potash	K_2O	1·32	1·10	1·21

Whale.—On certain coasts where the whaling industry is carried on (see this BULLETIN, 1914, **12**, 264), if the whale

meat is brought to shore it is often converted into manure. One of the processes in use for this purpose is the following: After the removal of the blubber and other fat, the flesh is cut into small pieces and cooked, by steam under 40 lb. pressure, on iron trays in an iron cylinder. The cooking lasts for about 10 hours, and the flesh is then pressed and dried. The latter operation is carried out in horizontal brick chambers, each about 25 ft. high, and having a central revolving shaft which carries trays upon which the cooked flesh is spread. By means of scrapers the flesh is gradually passed to the lower shelves, and to the exit at the bottom. The bones are often dried, ground, and added to this manure. The percentage composition of whale manure is approximately: nitrogen, 7.5; phosphoric acid, 13·5; lime, 16·5; water, 5·0.

Complete statistics of production of whale manure are not obtainable, as some of the larger producers do not distinguish between whale and herring manure.

The production of whale guano in Newfoundland was 523 tons in 1913, as compared with 655 and 672 tons in 1911 and 1912 respectively. Considerable quantities are produced in British Columbia, the amount marketed in 1912–13 being 1,484 tons, valued at £11,592. The exports from the Union of South Africa in 1912 and 1913 were 2,520 tons, valued at £16,694, and 651 tons, valued at £3,619 respectively. In the Falkland Islands both whale oil and manure are produced. In the 1911–12 season 30,270 bags of the latter, valued at £14,872, were produced in South Georgia.

Crabs.—For a number of years the horseshoe crab (*Limulus polyphemus*) was caught along the Atlantic coast of the United States for the purpose of making manure. The crabs were chiefly taken by means of pound nets when they visited the shore during the spawning season. At the present time the waste from certain crab canneries in the United States is dried, ground, and sold as a "filler" for fish manure. A partial analysis made in the Soils Bureau of the United States Department of Agriculture of such a product gave the following percentage results: Nitrogen, 3·82; phosphoric acid, 4·55; moisture, 6·95; oil, 2·11.

Lobsters.—The refuse from the lobster canneries in Nova Scotia, New Brunswick, and elsewhere is used in much the same way as crab waste. Lobster-shells contain, when dry, about 4 per cent. of nitrogen, 3 per cent. of phosphoric acid, and 20 per cent. of lime.

Shrimps.—The shells and the refuse from the preparation of canned shrimps form a manure much favoured by the Chinese on the Pacific coast of the United States. The manure is said to be specially suited for the manuring of strawberries and vegetables in California, and to be much used in China for manuring rice and tea.

Manurial Value of Fish Products

The analyses of fish manures quoted above show that these products are all deficient in potash, and for this reason much of the fish manure made in the United States is not sold to the farmer as such, but is used as a component of a complete manure. As the nitrogen in fish manure is largely in an organic form, it becomes available for plant nutrition more slowly than if it were in inorganic form, *e.g.* as in ammonium sulphate or potassium nitrate. It thus happens that the nitrogen in fish manure is not so readily leached out of the soil as are the inorganic forms, and so is supplied to the plant during the whole season. It is stated, however, that it is more readily available than the nitrogen in dried blood, steamed bones, or hoof meal. The phosphoric acid in fish manure soon becomes available for plant nutrition, and as regards the availability of this constituent, fish manure is stated to be about equal to steamed bone, and superior to tankage, hoof meal, and wool waste.

The following percentage figures are of interest as indicating the condition of the phosphoric acid in ordinary dry scrap and in the wet and dried forms of acidulated scrap:

	Acidulated scrap.		Dry scrap.
	Wet.	Dry.	
Water soluble phosphoric acid . . .	1·17	0·55	0·44 to 0·66
Citrate „ „ . . .	1·13	2·64	3·1 to 5·14
Insoluble „ . . .	2·58	5·06	1·7 to 3·3
Water in scrap	45·4	12·5	about 12

For the production of a complete manure from fish scrap of the type yielded by dog-fish, the following formulæ have been suggested by F. T. Shutt (*Canadian Exp. Farms Rep.*, 1906, p. 161):

	A. *lb.*	B. *lb.*
Fish meal	300	300
Nitrate of soda	100	50
Superphosphate of lime	300	400
Potassium chloride	50	150

A is stated to be suitable for cereals and grass, and B for potatoes, root crops, and clover.

Fish manure finds extensive use in the United States, Japan, etc.; in the United Kingdom it has been for many years a favourite with hop-growers, and is also used for root crops.

The manure should be ploughed into the land early in the year, as, like many other products of its class, it is somewhat injurious to germinating seeds until it has been in the soil for some little time and the more active fermentation is over. Fish manure gives the best results when used on moderately light, moist soils which contain a plentiful supply of lime.

Fish Meal as Cattle Food

Fish meal has been used with some success as a supplementary food for stock. It has also been successfully used in carp-ponds, but for this purpose it must be free from bones.

Various grades of meal made from cod, herring, or fish trades waste are now on the market. The results of partial analyses of certain of these are given below:

	Phosphoric acid. P_2O_5.	Lime. CaO.	Nitrogen. N.	Protein.	Fat.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Norwegian cod meal	10·9 to 12·8	—	—	50 to 60	1 to 2
Herring meal	3·6 ,, 4·6	—	—	60 ,, 70	10 ,, 12
English waste meal	6·4 ,, 8·2	—	—	55 ,, 65	3 ,, 6
German meal	—	—	—	59·8	2·53
Scotch ,,	5·84	—	8·57	—	14·9
English ,,	5·20	4·90	11·83	—	—

It is stated that the horned dog-fish, *Squalus acanthias*, is sometimes dried and used for feeding purposes in Scotland, Ireland, Norway, and elsewhere.

Cod meal may be made by simple drying and fine grinding of the fish, but in the case of the herring it is necessary to remove most of the oil by the usual process of cooking, pressing, and drying (see p. 430).

It is stated that good fish meal for feeding purposes should contain not less than 8·2 per cent. of nitrogen and not over 5 per cent. of oil.

Fish Glue

This product is made at many fish manure factories from the water in which the fish have been cooked. The aqueous liquid is separated from the oil and gurry (see p. 434), and clarified by the addition of a small quantity of alum. The solution is then filtered, concentrated to a strength representing 32 per cent. of dry glue, and bleached, if necessary, by means of sulphur dioxide.

The material is used by shoe manufacturers, bookbinders, and makers of boxes, musical instruments, artificial flowers, etc. The glue sells usually at about £1 10*s.* to £2 10*s.* per cwt.

TIN RESOURCES OF AUSTRALIA, SOUTH AFRICA AND NIGERIA

In a previous article an account was given of the tin deposits of the Malay Peninsula and Burma (see this Bulletin, 1914, **12**, 278). The Australian, South African and Nigerian occurrences are described in the following pages.

Australia

The most important tin fields of Australia are situated in Tasmania, Queensland and New South Wales. In 1912 the output of tin and tin ore from the different States of the Commonwealth was as follows:

		Quantity. *Long tons.*	Value. £
Tasmania	ore	3,713	543,103
Queensland	„	3,230	364,503
New South Wales	metal	900	338,074
	ore	1,175	
Western Australia	„	575	70,578
Northern Territory	„	270	27,001
Victoria	„	48	5,733
	Total value		£1,348,992

The tin-producing States will be considered in geographical order, beginning with the north-east of the continent.

Queensland

The fields producing tin ore in 1912, with their output, were as follows:

	Quantity. *tons*	*cwts.*	Value. £
Herberton	1,927	0	209,893
Chillagoe	504	0	51,777
Cooktown	272	0	36,233
Stanthorpe	166	5	21,428
Kangaroo Hills	163	0	20,340
Charters Towers	75	5	9,286
Etheridge	57	0	6,775
Palmer	37	5	5,006
Croydon	15	0	1,893
Ravenswood	13	5	1,848
Nanango	0	3	24
	3,230	3	364,503

All the tin fields are in the northern part of Queensland with the exception of Stanthorpe and Nanango, which are near the southern border.

The Herberton and Chillagoe tin fields are situated to the south-west of the port of Cairns, with which they are connected by railway. The country near Herberton is among the most mountainous in Queensland, ranging from 2,000 to 4,000 ft. above sea-level. It is traversed by the main dividing range of the State, while the Herberton Range on the eastern border prevents easy access to the coast. The rocks are slates, schists, and quartzites, with intrusions of biotite or hornblende granite, granite porphyry, or quartz felsite. Elvan dykes intrude into both the

plutonic rocks and the altered sediments. The tin lodes occur in an irregular manner. The lode material as a rule merges gradually into barren country rock, and varies from unaltered granite or quartzite to greisen and chloritic or kaolinic material. The tinstone (cassiterite) is often accompanied by topaz, fluorite, tourmaline, wolframite, bismuthinite, antimonite, galena, chalcopyrite and magnetite. Alluvial tin was first worked in this district in 1880, and the discovery of lodes near Herberton and Watsonville soon followed. Irvinebank, Koorboora, Stannary Hills, Sunnymount, and Newellton are other important lode-mining centres in these fields.

Farther north, in the Annan River tin field, south of Cooktown, the output is almost entirely stream tin, although lodes have been worked to some extent in the past. The district is one of rugged granite mountains, but the streams draining westward into the Annan River are held up by bars of harder rock, giving rise to an alternation of cascades and quiet reaches in which extensive alluvial deposits occur. Some of these deposits have been worked continuously for tin since the opening of the field in 1886. To bring water to the higher terraces, races had to be constructed, often several miles in length; water supply is a most important factor in many of the Queensland fields, and a dry season leads to a diminished output of tin.

The Kangaroo Hills tin field, about 100 miles south of Herberton, produced lode and alluvial tin in about equal quantities in 1912. Lodes have recently been discovered at Watercress.

Still farther south, in the Charters Towers district, a certain amount of lode-mining for tin is carried on, but the industry is quite overshadowed by the gold production of the district.

In the Stanhills tin field, near Croydon, cassiterite occurs in veins in granitic rocks, and is associated with chlorite, quartz, pyrite, galena, sphalerite and chalcopyrite. The Desert Sandstone, which overlies the granite and forms isolated flat-topped hills, is stanniferous in places. Alluvial deposits have been worked, but these

are not extensive and are of less importance than the lodes.

In the Stanthorpe district, near the New South Wales border, the first discovery of tin ore in Queensland was made in 1872. Lode mining has produced very little tin, but the alluvial deposits are still yielding good returns to modern methods of extraction, particularly dredging.

Cassiterite occurs, associated with gold, platinum and monazite, in the shore sands near Currumbin Creek, in the south-east of Queensland. Similar deposits are found on the coast of New South Wales.

New South Wales

The principal tin fields of New South Wales are situated in the north-east of the State, in the Inverell and Emmaville districts. Tin was first worked at Elsmore, near Inverell, in 1872. Here the cassiterite occurs as crystals disseminated through granite and greisen, and, on the decomposition of the rock, has become concentrated in surface deposits. It is associated in these deposits with some wolframite, and also with carbonate of bismuth. The wolfram is derived from lodes which intersect the granite, but which do not appear to be stanniferous.

Shallow alluvial deposits were soon discovered, and for the most part worked out, in the surrounding district, as at Newstead, Stannifer, Tingha, and Stanborough.

The bed of Cope's Creek, and also the alluvial flats bordering it, were rich in cassiterite. At Tingha, on this stream, dredging for tin was commenced in 1900 for the first time in New South Wales. In 1912 two-thirds of the total output of the State was furnished by dredging plants, of which there were thirty-five of the suction-pump type, and only four bucket-dredges. The suction-pump dredging method is really a form of hydraulic sluicing, steam pressure taking the place of a natural head of water; the plant is either stationary or on a movable barge or pontoon.

In addition to the Recent and Pleistocene superficial deposits, there are in the Tingha-Inverell district Eocene alluvials of similar origin and containing cassiterite derived from the same granitic rocks. These old valley deposits,

known as "deep leads," were buried beneath sheets of basaltic lava, which was accompanied by volcanic ash now altered to bauxite. The Elsmore Valley Lead is an example; there are three beds of wash-dirt, 10½, 1½, and 1 ft. thick, which are worked by a mine 225 ft. deep. The Newstead Lead was worked from its outcrop, and found to deepen gradually northward to a depth of 130 ft. or more.

Near the junction of Cope's Creek with the Gwydir River there are several hills of basalt overlying a Tertiary stream-deposit. This is worked for diamonds, which are small but numerous and are accompanied by topaz, sapphire, zircon, tourmaline, ilmenite, magnetite, spinel, cassiterite, etc. Although the tin is not in sufficient quantity to pay the whole cost of extraction, it forms a valuable by-product of the diamond-washing.

The Emmaville or Vegetable Creek district is some 40 miles to the north-east of Inverell and Tingha. The geological conditions are similar in the two districts. The oldest sedimentary rocks at Emmaville are bluish-grey claystones of Carboniferous age, which have been intruded by tin-bearing granite and by quartz felsites and diorites. There are Tertiary alluvial deposits and sheets of lava and volcanic ash, and finally Post-Tertiary stream-deposits.

Of the last type, the most productive was that of Vegetable Creek. The upper five miles of this stream are said to have yielded 15,000 tons of cassiterite between 1872 and 1884, the area worked being about 150 acres and the average depth of gravel washed about 2 ft. 6 in. Catarrh Creek also contained important shallow alluvial deposits, and there are numerous smaller occurrences in the district.

Of the Tertiary alluvial deposits some are capped by lava and some are bare, the lava having been removed by denudation. The most important deposit of the latter class is at the Y Water-holes. It has an area of 1,100 acres, and its depth averages about 20 ft. The deposit consists of current-bedded clay and sand, the richest ore occurring in the lower part and the next richest at the top, where the tin from denuded material has been concentrated. Scrubby Gully, Surface Hill, and Ruby Hill are other examples of bare Tertiary deposits.

Of the basalt-covered Tertiary leads in the Emmaville district, by far the most important is the Vegetable Creek Lead. In portions of its course there were two distinct flows of lava, each overlying a bed of stanniferous wash-dirt. The old stream had two main tributaries, giving rise to the Rose Valley Lead and Fox's Deep Lead. The latter, at its junction with the Vegetable Creek Lead, was struck at 247½ ft. from the surface, and is the deepest lead worked in the Emmaville district. At Bailey's Mine, Rose Valley, a stanniferous alluvial deposit is overlain by a felspar porphyry, the only known instance in Australia of a deep lead beneath an acid lava.

To the south of Vegetable Creek Lead is the Graveyard Lead, and the two leads probably unite about six miles west of Emmaville. From this point a strip of basalt-covered country runs northward to Kangaroo Flat and Avoca, where stanniferous drift has been worked, and it is probable that the lead will be found rich enough to be worked in intermediate localities.

Farther west are the Spring Lead, Rocky Creek Lead, and Ruby Hill Lead, and to the east is the Wellington Vale Lead, near Deepwater.

Lode-mining for tin has been carried on in the Inverell and Emmaville districts. The lodes include fissure veins, joint veins, pipe veins and stockworks, and occur chiefly in granite. The associated minerals occurring in different veins are quartz, felspar, chlorite, mica, mispickel, pyrite, fluorite, tourmaline, wolframite, sphalerite, galena, chalcopyrite, bismuth, molybdenite, vesuvianite, stilbite, hæmatite, pyrrhotite, manganese, scheelite and beryl. The ore in most of the veins shows a tendency to run in shoots inclined to the plane of the lode. The largest veins now worked are the Ottery, Dutchman, Butler's and Curnow's veins, all of which are from 3 to 4 ft. wide. Pipe veins are a peculiar feature of both the Inverell and Emmaville districts. They usually occur in granite, and are circular or oval in section, and up to 4 or 5 ft. in diameter. They consist of quartz, felspar and chlorite, with disseminated cassiterite, molybdenite, wolframite, etc., and pass gradually into unaltered country-rock.

Still farther to the north-east is the Wilson's Downfall district, which may be regarded as an eastward extension of the Stanthorpe tin field of Queensland. Shallow alluvial deposits have been worked in the Ruby, Maryland, Herding Yard, Cemetery, Wilson's Downfall, Wylie, Two-Mile, and Bookookoorara Creeks.

In the Barrier district, in the extreme west of New South Wales, tin occurs at Euriowie and Poolamacca. At Euriowie cassiterite is found in coarsely crystalline dykes of granite and greisen traversing gneiss and mica-schist. The dykes are usually from one to twenty feet thick and terminate abruptly with rounded ends. Work in this field has been greatly hampered by scarcity of water and distance from any railway.

In the central portion of the State, tin ore has been found in the valley of the Lachlan, at Burra Burra, Mount Tallabong, Mandamah, Ardlethan and elsewhere, mostly as stream tin, but also in veins.

In the south, the Albury, Germanton, Tumbarumba and Wagga Wagga mining divisions produce some tin.

Small quantities of finely-divided cassiterite, associated with zircon, garnet, ilmenite, monazite, gold and platinum, occur in some of the shore-sands, notably between Byron Bay and Clarence Head, and in lesser quantities between Port Macquarie and Cape Hawke, near Seal Rocks, and at Shellharbour, Termeil, etc.

Stannite occurs in considerable quantity at Howell and Tolwong. Native tin has been recorded in the Aberfoil and Sam rivers, near Oban.

Victoria

The tin production of Victoria is very small, amounting to 48 tons in 1912. It is derived from lode and alluvial mining, mainly on the Mitta Mitta River and other localities in the Beechworth district. At Tallandoon, cassiterite is obtained from dykes of pegmatite and greisen intrusive in schists. Stream tin occurs at Mount Wills, Beechworth, Eldorado, Chiltern, Stanley, Coetong and Cudgema in the north-eastern district; Tin Creek and

Agnes River in Southern Gippsland; near Bruthen in Eastern Gippsland; at Gembrook, Neerim, Darnum, the Bunyip and Tarago Rivers in Western Gippsland; Upper Yarra, and other districts.

Tasmania

The principal tin mines of Tasmania are the Mount Bischoff, in the north-west of the island, and the Briseis and Pioneer mines in the north-east. These three mines produced 1,110, 539, and 468 tons respectively in 1912, and together accounted for 57 per cent. of the Tasmanian output. All the tin ore produced is smelted at Launceston.

Cassiterite was first discovered at Mount Bischoff in December 1871. The mine is situated on the top of the mountain, 3,500 ft. above sea-level and 45 miles from the north coast at Emu Bay. Mount Bischoff consists of contorted slaty rocks traversed by dykes of topaz and quartz porphyry, while the surrounding plains are largely formed by sheets of basalt. The porphyry dykes carry topaz and cassiterite, and there are fissure-veins containing cassiterite, pyrite, arsenopyrite, fluorite, wolframite, tourmaline and siderite. There are also detrital deposits formed by the disintegration of the lodes.

The Briseis mine, discovered in 1872, operates a deep lead near the Ringarooma River. The cassiterite occurs throughout the drift, which is a coarse quartz sand and is covered by a sheet of olivine-basalt. This is for the most part decomposed and can be removed by hydraulic operations. The local water supply being insufficient, a race has been constructed to bring water from a distance of over thirty miles. At the Pioneer mine, lower down the Ringarooma River, the lead is in places covered by 40 ft. of cemented material which has to be blasted.

At the Anchor and other mines in the Blue Tier district a tin-bearing granite is worked. When the whole of the stone is crushed it averages about ½ per cent. cassiterite, but richer patches occur. The ordinary granite of the Blue Tier consists of quartz, felspar, biotite and a little muscovite. In the tin-bearing granite, muscovite and talc

replace the biotite, the felspar is frequently kaolinised, and there is the addition of cassiterite, wolframite, scheelite, fluorite, pyrite, molybdenite, galena and chalcopyrite.

Farther south, in the Ben Lomond and Avoca districts, tin lodes occur in granite which is overlain by Permo-Carboniferous grits and conglomerates. These contain water-worn fragments of the granite and of quartz and cassiterite, and constitute one of the most ancient deposits of alluvial tin hitherto recorded. Veins of wolframite and cassiterite occur in the Scamander district.

In the west of Tasmania, south of Mount Bischoff, is the North Dundas tin field, including the Renison Bell, Boulder, and Montana mines. Here the tin-bearing veins have a complex structure and are of two types, in one of which cassiterite is associated with quartz and tourmaline, in the other with sulphides. The latter type is the more important. Pyrrhotite is the dominant sulphide, though pyrite is sometimes abundant. Arsenopyrite and chalcopyrite are often abundant, and there is usually a certain amount of galena, sphalerite and bismuthinite, as well as wolframite. Stannite has been observed. The gangue minerals are quartz and dolomite with smaller amounts of tourmaline, chlorite, epidote and fluorite. The greater part of the tin ore hitherto produced has been won from the gossans arising from the oxidation of the sulphide lodes, the remainder from residual and alluvial drifts and the quartz-tourmaline-cassiterite lodes.

Immediately to the east of the North Dundas field, in the X River district, the same two types of lodes occur, but there are indications that they merge into one another.

In the Zeehan field, nearer the west coast, a variety of veins occur, only some of which carry tin. The metal is present as cassiterite associated with quartz, pyrite and tourmaline, and as stannite associated with pyrite, chalcopyrite, quartz, siderite, fluorite, bismuthinite, tetrahedrite, wolframite and galena.

In the Heemskirk district cassiterite occurs in the surface soil and rubble, and has been traced to the parent lodes. The country rock consists of Silurian sandstones and slate, with a granite outcrop in the vicinity.

Western Australia

In Western Australia, tin has been produced in considerable amounts only in the Greenbushes district and the Pilbara gold field, but it is known to occur also in the Kimberley district, the Thomas River in the Gascoyne valley, the Murchison and Coolgardie. The greater part of the output is stream tin.

The Greenbushes district is in the south-west of the State. Cassiterite occurs in pegmatite and quartz-tourmaline veins and impregnations in granite. This is covered by lateritic alteration products, which in places contain concentrated residual tin ore. This material usually requires crushing. More important sources of tin are the alluvial deposits in the stream valleys. The richest of these is in Spring Gully, where an upper layer of sand, known as "free dirt," rests on stiff white "clayey dirt." The former is particularly rich in tinstone. Tantalite and stibio-tantalite occur with the cassiterite in some of these deposits.

About twelve miles south of Greenbushes, tin ore has been obtained at Nannup or Smithfield.

In the Pilbara district, in the north-west division, tin ore is produced at Moolyella, Cooglegong, Old Shaw (Eley's Well), Green's Well, Wodgina, Stannum, and Mill's Find. At all these localities the source of the cassiterite is the pegmatite veins which traverse granite and hornblende schist. At Wodgina, where, unlike most other tin fields in the State, the output of lode tin has exceeded that of stream tin, the lodes vary from mere threads up to a width of 500 ft. or more, and carry tourmaline and tantalite. At Moolyella the pegmatite veins consist largely of albite. From these sources are derived the shallow alluvial and residual deposits which, in most localities, have yielded the greater part of the tin produced. Tantalite, monazite, gadolinite and euxenite are occasionally found with the cassiterite in these deposits.

Northern Territory

Many tin-bearing areas are known to occur in the Northern Territory, and Chinese miners have produced a

considerable amount of tin, but systematic work by modern methods has been neglected. At Mount Wells, however, lode-mining is carried on. West Arm and Bynoe Harbour also yield tin ore, and the mineral is known to occur at Horseshoe Creek, Burrundie, Maranboy, Umbrawarra, and Mount Shoobridge, where two small lodes were formerly worked. The discovery of tin-bearing lodes at Beswick Creek has recently been announced.

Union of South Africa

The only districts in the Union of South Africa producing tin ore in any considerable amount are situated in the north-western part of the Transvaal and in Swaziland. The total output of ore for 1912 was as follows:

	Quantity. *tons.*	Value. £
Transvaal	2,618	367,699
Swaziland	385	37,946
Cape Province, Natal, Orange Free State .	nil.	nil.
Total for the Union of South Africa .	3,003	405,645

The Cape Province produced 161 tons of ore in 1907, 44 in 1908, 27 in 1909, 18 in 1910, and 7 in 1911.

Transvaal

The Waterberg tin fields in north-western Transvaal include the Potgietersrust tin field (Zaaiplaats, Roodepoort, Groenfontein, Solomon's Temple, etc.), the Nylstroom tin field (Doornhoek, Kromkloof, Welgevonden), the Warmbaths tin field (Zwartkloof, Elandsfontein, Witfontein, etc.), and the Rooiberg tin field. All these localities lie on the eastern and southern margins of a geological basin, the central portion of which is composed of sandstones and conglomerates of Upper Waterberg age, constituting the Waterberg plateau. Below the escarpment of these beds is a belt of Lower Waterberg felsites with interbedded shales, and quartzites in the Rooiberg, overlying the Red Granite and the Norite of the Bushveld Plutonic Complex. Beyond the outcrop of these lie the Older Granite and the quartzites and dolomites of

the Transvaal System. These older rocks, however, are unconnected with the source of the tinstone, and the same may be said of the Karroo beds which overstep all these formations in the south-eastern part of the district. The Red Granite and the Lower Waterberg rocks are the important tin-bearing formations. In the Red Granite the cassiterite deposits occur—(*a*) in the form of roughly cylindrical pipes; (*b*) associated with irregular bodies of altered granite; (*c*) as irregular disseminations in slightly altered granite; (*d*) as impregnations along well-defined lines of fissure; (*e*) associated with pegmatite and quartz veins. In the felsites, shales and quartzites of the Lower Waterberg the deposits are found (*a*) in lodes and more or less definite lines of fissure, small veins and leaders, and (*b*) as irregular patches and pockets, often connected with fissures or determined by planes of stratification.

The most important deposits in the Potgietersrust tin field are situated on the farms Zaaiplaats, Roodepoort, Groenfontein and Solomon's Temple. They are distributed along a well-defined zone in the Red Granite, which strikes in a north-west and south-east direction and continues into Groenvlei and Appingadam in one direction and Welgevonden, Welgelegen, and Grootrivier in the other. This zone comes immediately below a coarse pegmatite. The usual type of deposit in this field is that of cassiterite-bearing pipes, roughly circular in section, descending at varying angles into the granite in a general north-westerly direction. They vary from two to twelve feet in diameter, and two of them have been proved to a depth of over 400 ft. on the incline. They usually occur in groups, and neighbouring pipes may unite either at depth or near the surface. The pipes sometimes show an outer zone of tourmaline-quartz rock, which is usually not more than a few inches thick. The main mass of the pipe varies from slightly altered granite to an apparently homogeneous greenish material which sometimes becomes extremely hard through secondary silicification. In the smaller pipes the cassiterite is fairly uniformly distributed, but in the larger ones it is generally more concentrated towards the periphery, and especially the lower portion,

while in the central portion it is less abundant or even absent. Cavities or vughs occur in some of the pipes; they are lined with quartz crystals and contain also fluorite, galena, sphalerite, and arsenical and copper pyrites. In addition to the pipes, several other types of ore body are found, some of which show a flat and more or less lenticular form. In one case there are several sheets of tin-bearing granite separated by barren rock. Fissure veins and irregular masses of altered tin-bearing granite also occur.

The Nylstroom tin field is situated on the farms Doornhoek, Kromkloof, and Welgevonden, some sixteen miles north-east of Nylstroom. The principal deposits are associated with the felsites and shales of the Lower Waterberg. The main lode at Doornhoek cuts the bedding-planes of the shales obliquely; it averages 18 in. in width, and is largely made up of brecciated and highly altered fragments of the country rock, with quartz, tourmaline, cassiterite and fluorite. A second lode follows one of the coarser beds in the shales, which also is much altered and brecciated. In the immediate neighbourhood of these lodes the shales sometimes show minute veins of cassiterite. A short distance below the base of the shales the underlying felsites carry cassiterite, associated with quartz and hæmatite, in small pockets from a half to one and a half inches in diameter, while other pockets contain tourmaline with quartz and sericitic matter.

The Warmbaths tin field extends from Zwartkloof through Droogekloof, Elandsfontein and Newbury to Witfontein and thence northward to Rhenosterpoort, forming a narrow belt which follows the junction of the felsites and the Red Granite. Cassiterite occurs in both types of rock, and there are also alluvial deposits. At Zwartkloof the ore bodies are somewhat irregular and ill-defined; they occur in the granite and are frequently associated with masses and veins of very coarse pegmatite and quartz. Alluvial and eluvial deposits occur on this farm. On Elandsfontein No. 1,782, there are two main sets of fissures in the granite, and the ore bodies associated with them vary in width from a few inches to two or three

feet. Fissure lodes also occur in the lower part of the felsites. On Witfontein No. 371, the alluvial deposits have proved more important than the occurrences in the granite and felsite. All three types of deposit occur also on Elandsfontein No. 2,149, and small quantities of tin have been won from the granite on Rhenosterpoort.

The Rooiberg tin field lies about forty miles west of Warmbaths. The cassiterite deposits, with the exception of one occurrence in the Red Granite, are all found in the Rooiberg quartzites, which, with the associated shales, are overlain with apparent conformity by the Lower Waterberg felsites, while both types of rock are intruded by the Red Granite. The workings are principally on the farms Olievenbosch and Hartebeestfontein, but also on Weynek, Quaggafontein, and Leeuwpoort, and many of them are on the site of ancient workings. The lodes in the quartzites coincide with two main sets of fissures, and there are also irregular pockets of mineralised rock rich in tourmaline and cassiterite. Other minerals frequently present are quartz, carbonates of iron and lime, felspar, hæmatite, pyrite and chalcopyrite. Superficial deposits of limonitic breccia, known as "ou-klip," are occasionally rich in tin. On Quaggafontein, cassiterite occurs in the upper portion of the Red Granite.

In the Bushveld tin field, forty miles north-east of Pretoria, cassiterite occurs in the Red Granite on the farms of Enkeldorn and Vlaklaagte.

Swaziland

In north-western Swaziland there are two tin-bearing districts, viz. the alluvial deposits of Embabaan and the surrounding country, and the lodes round Forbes Reef on the east side of the Ingwenya Range.

The alluvial deposits occur as "flats" along the course of the Babaan and other rivers. At King's Flat, to take a typical example, there is a soft overburden of about 12 ft. of dark soil, which carries little tin. Below this lies 2½ ft. of coarse tin-bearing gravel, composed largely of fragments of quartz up to 3 in. across, which rests on the granite floor of the valley. The cassiterite occurs

in the gravel as loose crystals, but occasionally in boulders of pegmatitic rock; it is associated with other accessory minerals of the granite, including monazite, euxenite, æschynite, corundum and tourmaline. Although no definite lodes have been found, there is little doubt that the cassiterite is derived from the granite which forms the surrounding country, and which has been identified with the Older Granite rather than the Red Granite of the Waterberg tin fields. There is an abundant rainfall and the conditions are favourable to hydraulic sluicing.

Forbes Reef is situated some fourteen miles north of Embabaan on the east side of the Ingwenya Range. This range is formed of quartzites and schists of the Swaziland System, which are intruded by the same granite as at Embabaan. In one case the tin occurs in a dyke in the schist, 2 to 3 ft. wide, composed almost entirely of white felspar with patches of chlorite and cassiterite. More usually the veins follow fissures parallel to the strike of the schists. Along these fissures the schist is tin-bearing over a width of about 3 in.

Cape Province

At Kuils River, about sixteen miles from Cape Town, tin-bearing lodes occur in a grey granite. Alluvial tin occurs in a creek on the farm Langverwacht, twelve miles from Cape Town. At Vredehoek, also near Cape Town, a series of small flat tin-bearing veins occurs in slates and quartzites of the Malmesbury Series, not far from a granite outcrop.

Southern Rhodesia

The Victoria tin field is situated between thirty and forty miles east of Victoria, and some fifteen miles N.N.W. of Ndanga. It consists of an area of metamorphic rocks bounded on three sides by a grey biotite granite. Pegmatite dykes and sills are found along the margins of the granite, and are also intruded into the metamorphic rocks at some distance from the granite. The latter dykes and sills are more or less altered to greisen and carry cassiterite. In the report of the local Geological Survey

for 1911 it is stated that there is a possibility of fairly large low-grade bodies being proved profitable to work.

The discovery of a tin lode has been reported on the site of ancient workings in the Hartley district some 180 miles from Buluwayo.

Nigeria

The principal tin fields of West Africa lie in the western part of Bauchi Province, near the centre of the Northern Provinces, Nigeria. The ore was washed and smelted by natives long before the advent of Europeans, and it is probable that the occurrences of "native tin" reported in the stream deposits are of artificial origin. Practically all the Nigerian tin now being produced is from alluvial deposits, where it is usually accompanied by small amounts of monazite.

The most important workings are on the Bauchi plateau, in the neighbourhood of Naraguta, Jos, Ngell, and Bukuru. The elevation is from three to four thousand feet above sea-level, and the climate is good. The alluvial cassiterite is derived from veins and impregnations in a soda granite intrusive in ancient crystalline rocks. Similar granite occurs in the Kwandokaya Hills to the north of Toro and in the Ningi Hills, and in each case carries tinstone. In the neighbourhood of Ngell, pyrite, chalcopyrite, tetrahedrite, sphalerite and galena are also present.

Cassiterite occurs in small quantities in the neighbourhood of Gadama and Fagam, on the borders of Bauchi and Kano, around Gantam and Aribi on the Nassarawa tableland, on the eastern slopes of the Vere Hills in Yola, and the western slopes of the Shebshi Hills in southern Muri, and in the neighbourhood of Eri in eastern Ilorin. In the last locality the mineral occurs in a pegmatite vein.

In the eastern part of the Southern Provinces, Nigeria, cassiterite occurs in the stream deposits near Akwa-Ibami, Uwet district, the average amount being 3 lb. per ton (see *Reports on the Mineral Survey of Southern Nigeria* for 1903–4 and 1904–5 [Cd. 2876], p. 22), while smaller amounts have been found in many other localities both in the Southern and Northern Provinces, Nigeria (*loc. cit.* and *Reports on*

the Mineral Survey of Northern Nigeria [Cd. 2875, 1906], [Cd. 3914, 1908], [Cd. 3915, 1908], [Cd. 4719, 1909], and [Cd. 5899, 1911].

The output of Nigerian tin ore in 1912 was 2,803 tons, valued at £336,330.

THE TRADE IN PALM KERNELS

THE two chief products obtained from the West African oil palm are palm oil and palm kernels. The former is obtained from the pericarp or outer pulpy layer of the date-like fruit of the oil palm, whilst the kernels are secured by shelling the palm nuts, which are obtained when the pericarp is removed from the fruit.

Of these two products palm oil has always occupied a very important place in the commerce between the United Kingdom and its West African possessions, but the commerce in palm kernels has until the last few years been left entirely to Germany, which has thus secured practically a monopoly of a very valuable trade and of the industries which depend on it. The technical features of the West African palm oil industry have been fully discussed in two long articles published in previous numbers of this BULLETIN (1909, **7**, 357; 1913, **11**, 206), and the reader may be referred to them for general information on the whole subject. In the present article it is merely proposed to call attention to the magnitude of the trade in palm kernels and to the desirability of British merchants and manufacturers using the opportunity afforded by the European war of securing a large proportion of this trade for this country. The quantities and values of the exports of palm kernels in 1912 from each of the chief producing countries in West Africa is shown in the following table:

	Quantities. *Tons.*	Values. £
British Possessions:		
Gambia	445	6,518
Gold Coast	14,629	205,365
Nigeria	184,624	2,797,411
Sierra Leone	50,751	793,178

	Quantities. *Tons.*	Values. £
French Possessions:		
Dahomey	36,708	535,937
Gaboon	354	4,671
Guinea	5,054	41,079
Ivory Coast	6,692	70,710
Senegal	1,736	28,221
Belgian Congo	—	110,835
German Possessions:		
Kamerun[1]	15,742	220,300
Togoland[2]	11,456	168,978

Liberia and Portuguese West Africa. Recent figures not available.

[1] *Duala, the capital of Kamerun, was occupied by an Anglo-French force on September 27 last.*

[2] *Togoland was occupied by an Anglo-French force on August 7 last.*

These figures are sufficient to indicate the importance and value of this trade. The following table, giving the distribution of the exports of palm kernels from the British Possessions in West Africa during the period 1910–12, shows that practically the whole of this trade is in the hands of Germany.

EXPORTS OF PALM KERNELS FROM BRITISH WEST AFRICA

Nigeria

	1910.		1911.		1912.	
	Tons.	£	*Tons.*	£	*Tons.*	£
United Kingdom	22,156	300,157	22,884	318,943	25,491	365,461
Germany	143,966	2,071,574	145,783	2,166,106	140,036	2,175,736
Holland	6,876	79,083	7,503	86,290	14,433	181,639
South Africa	—	—	219	3,066	4,664	74,575
Total	172,998	2,450,814	176,389	2,574,405	184,624	2,797,411

Sierra Leone

	1910.		1911.		1912.	
	Tons.	£	*Tons.*	£	*Tons.*	£
United Kingdom	4,652	71,083	9,654	149,433	8,846	140,963
Germany	38,297	572,369	33,238	507,915	41,904	652,210
Other countries	82	1,232	—	—	½	5
Total	43,031	644,684	42,892	657,348	50,751	793,178

Gold Coast

	1910.		1911.		1912.	
	Tons.	£	*Tons.*	£	*Tons.*	£
United Kingdom .	2,667	34,898	2,430	30,967	2,772	37,548
Germany . .	11,286	146,989	10,110	135,187	11,079	157,322
France . . .	299	3,171	714	9,736	768	10,370
Other countries .	—	—	—	—	10	125
Total . .	14,252	185,058	13,254	175,890	14,629	205,365

Gambia

	1910.		1911.		1912.	
	Tons.	£	*Tons.*	£	*Tons.*	£
United Kingdom .	467	5,640	443	4,756	445	6,518

Almost the whole of the palm kernels imported into Germany are received through Hamburg, and consequently the following table, showing the imports to Hamburg in each of the last three years, gives a good idea of the value of this trade to Germany.

Imports of Palm Kernels to Hamburg

	Tons.	£
1911 . . .	262,680	4,789,590
1912 . . .	283,536	5,263,274
1913 . . .	241,961	5,233,252

Uses and Value of Palm Kernels

Palm kernels are used in Germany as a source of oil (palm-kernel oil) and feeding-cake (palm-kernel cake). The average value of the kernels in Hamburg ranges from £18 2*s.* to £19 2*s.* per ton (June 1914); the value in Liverpool was £17 17*s.* 6*d.* to £18 18*s.* 9*d.* per ton in July last, and is now £16 7*s.* 6*d.* to £17 10*s.* per ton (September 1914).

Palm-kernel Oil

The quantity of oil yielded by the kernels varies from 46 to 53 per cent. Practically all the palm-kernel oil of commerce is expressed in Europe, the chief centre being Harburg, near Hamburg, though some is expressed in

Liverpool. Attempts have been made to express the oil on a large scale in West Africa, but these have not proved altogether successful. The natives prepare small quantities of palm-kernel oil by crude methods, but this is entirely for their own use.

On the commercial scale palm-kernel oil is obtained either by extraction with solvents or by expression. In the latter case, the crushed kernels must be pressed twice on account of the large amount of fat contained in them. The first expression is usually carried out at a temperature of 45–50° C., and the second at 55°–60° C. By this means about 43–45 per cent. of palm-kernel oil is obtained, corresponding to a yield of about 1,000 lb. of oil per ton of palm kernels. By extraction with solvents the whole amount of oil or any desired proportion of it can be recovered at will; but if all the oil is taken out the residual meal is less valuable as a feeding-stuff, and in addition it is frequently asserted that the cake is then unsuitable for use as a feeding-stuff, and that the oil obtained is not of edible quality. It is, however, fairly certain that with proper care and the use of suitable solvents the residual meal can be obtained suitable for feeding purposes and an oil of edible quality prepared by extraction processes (*see below*).

Palm-kernel oil at European temperatures is a white or pale-yellow solid fat possessing a pleasant nutty taste. It closely resembles coconut oil in appearance and properties. The following table gives the range of the principal constants of commercial palm-kernel oil. The corresponding figures for coconut oil are added for comparison.

	Commercial palm-kernel oil.	Coconut oil.
Specific gravity at $\frac{99^\circ\text{ C.}}{15^\circ\text{ C.}}$	0·873	0·874
Iodine value *per cent.*	10·3–17·5	8·0–10·0
Saponification value	242–255	246–268
Titer test	20·0° C.–25·5° C.	21·2° C.–25·2° C.
Hehner value	91·1	82·4–90·5
Reichert-Meissl value	5·0–6·8	6·6–7·5
Polenske value	—	18·0
Yield of oil	46·7–52·5	64·5–74·7

Palm-kernel oil is used for the same purposes as coconut oil, viz. the manufacture of soap and candles and the preparation of various edible fats, such as margarine, cooking fats, vegetable "butters," and chocolate fats. By suitable treatment it can be separated into a liquid portion (olein) and a hard white fat (palm-kernel stearin), and in this way the consistence of the material can be varied for the preparation of different edible products. These edible palm-kernel oil products are prepared on a very large scale in Germany and elsewhere, and are largely imported into this country. With palm kernels at £17 to £18 per ton the value of palm-kernel oil in the United Kingdom is from £36 5*s*. to £36 15*s*. per ton with Ceylon coconut oil at £40 per ton.

Palm-kernel Meal

The meal which is left, after expression or extraction of the oil from palm kernels, is of value as a cattle food. The cake has not a very pronounced flavour and is usually fed in the dry state. In Germany it finds a good sale, especially as a food for young pigs, and, like coconut cake, it is said to improve the fat content of the milk when fed to cows. On this latter point Mr. E. W. Thompson, Commercial Agent of the Department of Commerce of the United States, who has recently investigated the possibility of increasing the market for American cotton-seed meal in Germany, says, "Palm-kernel meal from the local (German) mills has made a fine reputation as a milch-cow feed and sells itself." On the question of the suitability of palm-kernel meal prepared by extraction processes for feeding purposes the same author says, "Palm kernels are largely worked by the solvent process, delivering meals with about 19 per cent. protein and 2 per cent. fat as compared with 18 per cent. protein and 8 per cent. fat for meal from hydraulic presses. The digestibility of the solvent meal (known in Germany under the general name 'schrot') is more satisfactory than the other—80 per cent. against 73."

The following table gives the composition and current

value of palm-kernel cake in comparison with coconut, linseed, and cotton-seed cakes:

Name of Cake.	Composition, *per cent.*						Current Value, *per ton.*
	Moisture.	Crude protein.	Fat.	Carbohydrates (by difference).	Crude fibre.	Ash	
Palm-kernel cake:							
(1) expressed	9·7	17·7	8·6	36·2	23·8	4·0	£6 8*s.* to £6 12*s.* (Hamburg, June 1914).
(2) extracted	10·9	18·7	1·6	39·1	25·4	4·3	—
Coconut cake (expressed)	10·5	21·4	8·5	38·7	14·7	6·2	£7 8*s.* to £8 3*s.* (Hamburg, June 1914).
Linseed cake:							
(1) expressed	11·0	33·5	8·6	31·7	8·7	6·5	English, guaranteed 95 per cent. linseed, £8 12*s.* 6*d.* to £8 17*s.* 6*d.* (Hull, September 1914).
(2) extracted	10·2	37·4	3·8	32·7	9·1	6·8	—
Cotton-seed cake:							
(1) decorticated	8·0	46·2	8·9	22·9	7·0	7·0	English, £9 5*s.* to £9 7*s.* 6*d.*
(2) undecorticated (both expressed)	10·5	24·5	6·5	26·3	25·0	7·2	English, £6 5*s.* to £6 7*s.* 6*d.* (Liverpool, Sept. 1914).

The Market for Palm-kernel Oil and Meal

A considerable proportion of the palm-kernel oil produced in Germany is exported either as such or in the form of prepared edible and other fats, but practically the whole of the palm-kernel cake or meal made is consumed in the country itself, the consumption in 1912 amounting to 120,000 out of a total of 138,816 metric tons produced (E. W. Thompson).

In the event of the palm kernels now exported to Germany from British West Africa being diverted to this country, British oil-seed crushers who undertook to work them would find no difficulty in getting a market for the oil among soap-makers and makers of edible fats in this country. There might, however, be some difficulty in finding a market quickly in this country for the palm-kernel cake, owing to the fact that English farmers are extremely conservative and do not readily take up feeding-stuffs which are new to them. It is stated, for example, that this very conservative attitude of the English farmer is largely responsible for the decline in the imports of soya beans to the United Kingdom in the last year or two, owing

to the fact that it proved impossible to create a large market in this country for soya cake, although it rapidly became popular in Germany.

The manufacturer of palm-kernel cake in the United Kingdom would therefore probably have to depend largely at first on the makers of compound cakes to absorb his produce, but in face of the abundant German evidence of the high feeding value of palm-kernel cake it should not be difficult for the manufacturer to popularise gradually this material among farmers and cattle keepers in the United Kingdom.

There is room for an enormous extension of the production of feeding-cakes in the United Kingdom, since no less than 406,700 tons of such cakes, valued at £2,539,892, were imported, chiefly from foreign countries, in 1913. The imports are principally cotton-seed, linseed, and rape-seed cakes.

TRADE AND INDUSTRIES OF SEYCHELLES

A COPY of the Report of the Collector of Customs on the Trade of Seychelles for 1913 has been received recently, and as it is of considerable interest as indicating the present state of the agricultural and other industries of the Colony, the Colonial Office has sanctioned the publication of the following summary of its contents. Previous articles dealing with the trade and agricultural products of Seychelles will be found in this BULLETIN (1904, **2**, 269; 1908, **6**, 107; 1909, **7**, 262, 394; 1910, **8**, 413; 1911, **9**, 280; and 1912, **10**, 120).

The total value of the imports in 1913 was Rs. 1,279,942 (R. 1 = 1*s.* 4*d.*), as compared with Rs. 1,176,511 in the previous year. The more important items were as follows: Foodstuffs, chiefly from India, Rs. 518,719; cotton goods, mainly from the United Kingdom, India, and France, Rs. 203,305; spirits, wine, and beer, Rs. 90,029; sugar, entirely from Mauritius, 343,028 kilograms, valued at Rs. 58,350; haberdashery, Rs. 48,865; hardware and iron-ware, Rs. 45,177; machinery, Rs. 33,880, an increase of Rs. 26,217 as compared with 1912, due to the importation

of plant for the distillation of essential oils; soap, almost entirely from the United Kingdom, Rs. 19,290; boots and shoes, Rs. 17,752; kerosene, from America and South Africa, Rs. 13,917; tobacco, chiefly from Réunion, United Kingdom, and Holland, Rs. 11,298.

The total value of the exports in 1913 amounted to Rs. 2,484,202, being a net increase of Rs. 727,154 over the previous year, and the highest value on record. The commodities which show increases include copra, guano, caret (tortoise) shells, essential oils, rubber, salted fish, coir, and turtle bones. The following products show decreases: vanilla, cinnamon bark, coconut oil, soap, coconuts, whale oil, calipee, and coco de mer. The principal exports in 1912 and 1913, and the countries of destination in the latter year, are shown in the following table:

	Quantity.			Value.		Country of destination in 1913.
	Unit.	1912.	1913.	1912.	1913.	
				Rs.	Rs.	
Copra	cwts.	53,844	58,865	801,196	1,080,736	France, United Kingdom, Germany, Belgium.
Guano	cwts.	310,260	694,400	465,414	1,041,600	Chiefly to Belgium, United Kingdom, Holland, and New Zealand.
Vanilla	cwts.	157	120	151,331	101,847	Chiefly to United Kingdom.
Caret shells	—	—	—	35,025	63,633	France, United Kingdom, and Germany.
Cinnamon bark	cwts.	22,205	13,962	93,305	53,305	Not given.
Coconut oil	gallons	13,426	10,697	32,381	25,604	Not given.
Soap	cwts.	2,365	1,271	43,800	23,288	Chiefly to German and French Colonies.
Calipee	cwts.	315	123	28,547	16,501	United Kingdom.
Essential oils	gallons	506	924	7,700	16,482	France, Germany, and United Kingdom.
Salted fish	—	—	—	6,949	7,422	Largely to Réunion.
Coconuts	number	182,327	103,350	9,912	5,473	Madagascar, Aden, France, Mauritius, and South Africa.
Whale oil	gallons	23,659	4,622	48,000	4,542	United Kingdom.
Rubber	lb.	677	1,768	2,265	4,165	United Kingdom.
Boats and accessories	—	—	—	7,150	13,975	Madagascar.

Other items of export in 1913 in order of value were coco de mer (Rs. 2,846), turtle bones (Rs. 1,350), hides (Rs. 1,235), trepangs (Rs. 1,106), sharks' fins (Rs. 652),

green turtle shells (Rs. 443), vacoa mats (Rs. 410), citrate of lime (Rs. 354), and coir (Rs. 255).

It is interesting to note the considerable increase in the exports of copra, but this has been responsible for a decrease in the exports of coconuts and coconut oil, and the scarcity of the latter has led to a decline in the manufacture of soap.

The increase in the exports of guano is stated to be due to a more serious exploitation of the deposits in the Aldabra group of islands (cf. this BULLETIN, 1911, **9**, 39).

It will be seen that cinnamon bark shows a very considerable decline. This bark is obtained chiefly from trees felled in clearing new land, and is gradually diminishing in quantity, and it is thought that its export will eventually cease.

The essential-oil industry continues to increase in importance, and new distillation machinery has been installed. The exports comprise chiefly oils distilled from cinnamon leaves, clove leaves, and lemon grass.

An important addition to the industries of the Colony is that of whaling. A British whaling company started at Seychelles in August 1913 with one motor whaler. Under the Whale Fishery Ordinance (No. 11 of 1913), the licence duty is Rs. 300 per annum for one factory and one whaler. There is at present no restriction with regard to the killing of cows, but it is proposed to frame regulations in that direction with the object of checking this suicidal policy. The export duty on whale oil is R. 1 per 100 litres, and R. 1 per ton for whale manure. In previous years the waters of Seychelles have been periodically visited by United States whalers, the last occasion being in 1912, when oil to the value of Rs. 48,000 was shipped to the United States.

GENERAL NOTES

Cotton Cultivation in French Colonies.—At the annual meeting of the French Colonial Cotton Association in March 1914 a report was made on the results achieved during 1913, and this has been published in the *Bulletin de l'Association Cotonnière Coloniale* (1914, **12**, No. 60).

The Association has furnished supplies of cotton seed to Morocco. Samples of cotton have been received from Showia which lead to the belief that, when the pacification of the country has been completed and the means of transport improved, good crops will be produced in this part of Morocco. Several consignments of cotton from the Ujda region have been sold and greatly appreciated. The results obtained in Algeria were somewhat disappointing on account of the continuous drought. Good progress has been made in Dahomey, but the industry will not undergo great extension until the railway has opened up the northern parts of the Colony. Very promising results have been obtained in the Ivory Coast, and it is hoped that the efforts of the Administration will lead the natives to improve their methods of cultivation. Considerable advance has been made in parts of Oceania, and especially in New Caledonia. The total quantity of cotton produced under the auspices of the Association in 1913 amounted to 715,511 kilograms, as compared with 608,500 in 1912; this does not include the exports from Indo-China, which are not under the control of the Association. The following are the quantities (kilograms) produced in the various Colonies in 1912 and 1913:

	1912.	1913.
Senegal	20,000	7,723
Upper Senegal and Niger region	100,000	98,751
Dahomey	125,000	175,450
Ivory Coast	—	39,737
New Caledonia	165,000	258,030
Tahiti	15,000	15,820
Algeria	180,000	120,000
Madagascar	3,500	—
	608,500	715,511

Agricultural Development of Sumatra.—The state of chronic warfare in Achin, the northern part of Sumatra, was brought to a close about five years ago, and consequently the conditions for development and employment of capital greatly improved. This circumstance, and the profits anticipated from rubber growing attracted the attention of capitalists to the island, where there was much land to be acquired, and many coffee plantations could be bought and transformed into plantations of Hevea.

An account of recent progress in the island is given in *Agronomie Tropicale* (1914, **6**, Pt. ii, 47, 61), based largely on the reports of Belgian consuls. Sumatra is traversed lengthways by a range of mountains which is situated much nearer the west coast than the east; consequently the eastern side possesses land much better suited for plantations, and also has a network of navigable rivers. The Deli district on the east coast has long been well known for its tobacco. Plantations of this and of coffee caused its

rapid development, but until recently the rest of the island, with the exception of Padang on the west coast, was quite unprogressive. Now, however, plantations are being established in many other parts, a preference being given to situations on the rivers.

The products of the oil palm and of the coconut palm are among those being exploited, as mentioned on pp. 481, 483 of this BULLETIN. The hilly districts are suitable for tea cultivation, which has been commenced in the island and has good prospects, but in some parts the want of roads presents a difficulty. The tobacco industry has yielded enormous sums since it was first started in the island, and the yield in 1912, after deducting the cost of production, is estimated at about £3,000,000, nine-tenths of the production going to the Amsterdam market. As regards rubber, the Brazilian Commission which visited the East Indian islands, the Straits, and Ceylon in 1911–12 estimates that the area planted and ready to be planted with Hevea rose from 6,140 acres in 1906 to 220,000 in 1912, and that the capital employed was £10,420,000, the rubber boom being the cause of this great increase. The production was expected to be 8,000 tons in 1914, 12,000 tons in 1915, and to reach 44,000 tons in 1919, without taking into account trees planted after 1912. Generally speaking, the trees that the Commission saw were healthy and free from root-rot and the attacks of white ants, though here and there they had suffered by tempests. There is a considerable difference in the rainfall in different places, but it is everywhere sufficient. Owing to good soil, the trees can grow at altitudes up to 1,000 ft., but they are usually situated at altitudes between 4 ft. and 120 ft. The Assam rubber tree, *Ficus elastica*, is grown in the Benkoelen, Tapanoeli, and Achin provinces.

The chief hindrances to the development of the island are the lack of means of communication and the scarcity of labour; but the Government is going to take active steps to remedy the former of these, and to overcome the latter it has since 1905 been settling Javanese families on land prepared for them. The establishment of rice cultivation by means of irrigation on the west side, and especially in the Benkoelen province, is also contemplated. Some progress has been made in recent years in the island, but it is only small in comparison with the great possibilities of development offered by the vast amount of unoccupied land awaiting exploitation when capital, labour, and roads and railways are provided. Hope lies in the direction of an overflow of population from Java.

The report of the Belgian Consul at Medan for 1912 gives very full information about the East Coast Province of the island. Here tobacco growing, which dates from 1864, was the only cultivation up to 1890, and is still the most im-

portant. There are 99 plantations belonging to 36 companies and 2 private individuals. Some companies have given up tobacco growing for some time in favour of rubber; omitting these, the capital of the tobacco plantations is a little over £4,000,000; the area under tobacco in 1912 was about 50,000 acres, and the bales produced weighed about 21,600 tons; some of this tobacco fetched in Holland 2·29 florins per half kilogram (3*s.* 6*d.* per lb.).

Coffee cultivation is declining. Formerly Hevea was planted as an intercalary crop in the coffee fields, but now the reverse is the case, and the coffee trees will be eliminated as the Heveas become ready for tapping. Formerly Liberian coffee had the preference, but since 1908 Robusta has been preferred for planting with the Heveas. In 1911, 1,338 tons of coffee, almost entirely Liberian, were exported, whilst in 1912 only 693 tons were exported, of which 98 tons were Robusta and 13 tons Arabica, the rest being Liberian. Robusta coffee is preferred by the planter because it is productive after three years, whilst Liberian gives scarcely any harvest before the fifth or sixth year.

As in other places, the cultivation of rubber trees has made great advances since the beginning of the century; in 1902 there were only about 400 acres planted with Hevea, whilst at the end of 1912 the acreage had increased to 197,530. In addition to this the area planted with *Ficus elastica* (rambong) by European companies is estimated at 7,000 to 10,000 acres, and there are native plantations besides. The export of rubber in 1912 from the East Coast Province was 1,926 tons, of which 1,466 tons were Hevea rubber. The nominal capital concerned in the rubber plantations at the end of 1912 was £10,600,000, of which about half was British.

Tea growing was only introduced in 1910–11, being started by an English company in the district of Siantar at an altitude of 600 to 1,000 ft. Eight more plantations have since been made, and some new tea companies with English or Dutch capital have been formed.

Other cultivations of the Province are coconut palms, oil palms, gambier, tapioca, pepper, sago, and rice.

Toxic Action of Roots on Vegetative Growth.—The effect of growing grass above the roots of fruit and other trees has been under investigation since 1895 at the Woburn Experimental Fruit Farm (see this BULLETIN, 1912, **10**, 184), and has been found to be most injurious. If trees are planted, and if the ground is then grassed over, either by sowing or by replacing the turf, there is an arrest of all healthy growth, and the trees are stunted; in the case where well-established trees are grassed over the effect is not so immediate. An account of experiments to discover the cause is given in the *Journal of Agricultural Science* (1914,

6, 136). The effect varies with the nature of the soil and the plant; the nature of the grass does not make much difference, but the vigour of its growth has an influence. The stunting action is accompanied by other indications of starvation; the foliage and bark are of an unhealthy light colour, and there is a marked deficiency of green colouring matter in the fruit; these effects, however, are not caused by a deficiency of plant food or water in the soil.

Experiments were made in which trees and plants were grown in large pots; and perforated trays, in which grass or clover could be grown, were placed above the soil in these pots. In this way the drainage from the grass or clover in the trays percolated through to the roots of the plants growing in the pots. After a time, when in most cases those without grass were mature and fruiting, the plants were removed, dried at 100° C., and weighed, and it was found that those grown under grass or clover had not reached maturity, and weighed usually much less than those grown under bare soil. In some pots, however, the plants growing under grass were allowed to grow on and come to maturity; in these it was found that the plants weighed even more than those grown under bare soil.

The results led to the conclusion that a toxin must be produced by the grass or clover, which reaches the roots of the plants beneath, producing the ill-effects observed. The toxin is probably not an excretion from the plant, but results from the debris from the growing roots, or perhaps is the result of an alteration in the bacterial contents of the soil caused by the growth of the grass. In some experiments the grass was grown in trays away from trees, and the drainings, after having been exposed to the air for an hour or two, were applied to the trees; it was then found that the toxin seemed to have become oxidised, and that the drainings now caused increased growth instead of injury. This affords an explanation of the increased weight when the plants under grass were allowed time to make up for their retarded development and to attain maturity. The conclusion is that the effect of the toxin formed by the grass is eventually overpowered by the beneficial effect of some other substance formed, probably merely the oxidation product of the previously formed toxin itself. It is even possible that partial grassing might have a beneficial effect when the grass is at such a distance from the tree-roots that the toxin becomes oxidised before reaching the roots. Recovery from the toxic effect may not always occur, as the plant may be permanently injured; this is likely to occur with hard-wooded plants, which may become permanently stunted. Scarcely any instances of recovery from the grass effect have been noticed with fruit trees at the Experimental

Farm. In some experiments grass and clover were grown both in the trays and in the pots, with the result that the plants in the latter were greatly injured.

The final conclusions were: Every growing crop results in the formation of a substance which is toxic to the growth of other plants, and still more so to itself. By oxidation this toxin loses its toxic properties and enhances the fertility of the soil. The plants previously poisoned eventually outstrip those which have not been subjected to the poisoning, except in cases where the toxic effect has been sufficient to produce a permanent stunting. It has also been found that the heating of a soil produces toxic matter from the organic substances present in it, and in much greater quantities than that produced by the growth of a crop. In both cases the toxin, after oxidation, increases the fertility of the soil.

The Destruction of Locusts by Bacteria.—In 1910 M. F. H. d'Hérelle discovered a disease of locusts caused by a bacillus which he named *Coccobacillus acridiorum*. He found that the disease could be transmitted to healthy locusts by inoculating them with the bacillus, and that by successively inoculating about twelve series of insects the virulence of the disease increased so that the locusts were killed in about eight to ten hours. In order to ascertain whether the disease could be employed on a practical scale for the destruction of migratory locusts in the field M. d'Hérelle was commissioned by the Argentine Government to carry out experiments in that country. On January 16, 1912, a large number of locusts were enclosed in an area of just over an acre near Escalada, and the ground was sprayed with half-a-litre of a culture of a high degree of virulence. After four days 75 per cent. of the insects were dead, and all the rest which had contracted the disease succumbed in a further four days. The disease spread rapidly from the centre of infection, and at the end of two or three days was found about 27 miles away, and after eight days about 48 miles off. Equally satisfactory results were obtained when larger areas were sprayed. As a result of the experiments near Escalada and in other parts of the country the Argentine Government decided to establish a station for the preparation of the bacillus culture on a large scale, and cultures have also been prepared at the Pasteur Institute and distributed to various countries. It is claimed that the disease is not only fatal to different kinds of locusts, but also to ants, which are a serious pest in most tropical countries; it does not affect, however, chickens, rabbits, or other animals (see *Comptes Rendus*, 1911, **152**, 1413; 1912, **154**, 623).

The results obtained in other countries have varied. Satisfactory results are stated to have been obtained in

Colombia, Venezuela, and Algeria, but in the Union of South Africa and the Philippine Islands the results were not so good.

In South Africa experiments were made in 1912 on a non-migratory grasshopper, *Zonocerus elegans*, migratory locusts at the time being practically absent from South Africa. Land which was thickly infested with the grasshopper was sprayed with a highly virulent culture; but although some of the insects contracted the disease, it apparently had little, if any, effect in decreasing their number. The experiment, however, was not regarded as conclusive, and the slight extent to which the disease spread in the field was thought to be due most probably to the insects having become fully mature and having almost ceased to feed, coupled with the fact that heavy rains fell at the time and probably washed the infection from the vegetation. The Chief of the Division of Entomology states that "it appears to me in the light of the experience gained, and from the information given by the Pasteur Institute, that the disease at best can be used only as a supplementary measure in dealing with an invasion of locusts under the conditions that prevail in South Africa" (*Agric. Journ. Union of S. Africa*, 1913, **5**, 607). It is further pointed out that a culture of sufficient virulence takes some time to prepare, should be made by a competent bacteriologist, and must be used soon after it is prepared, whereas arsenical poisons can be stored for any length of time in different parts of the country, and can thus be used for the destruction of locusts as soon as they make their appearance.

Inconclusive results were also obtained in the Philippine Islands. Cultures of the disease were brought to their maximum virulence in the laboratory, after which a thorough test was made under actual field conditions on a swarm of half-grown migratory locusts (*Pachytylus migratoroides*). Very little effect was produced; a few insects were found dead, but there was no evidence of the disease spreading (*Philippine Agric. Rev.*, 1913, **6**, 547).

More satisfactory results have been obtained in Cyprus, where experiments were carried out recently by the Government Analyst. An extract from his report on the results of the experiments has been received from the Colonial Office, of which the following is a summary. The kind of locust experimented on is not stated in the report, but a collection of the locusts found in Cyprus was received at the Imperial Institute in 1911, and the one most destructive was identified by Mr. F. V. Theobald as *Pachytylus nigrofasciatus*.

The Cyprus Government received through the kindness of M. d'Hérelle three tubes containing cultures of the bacillus. On March 31, 1913, a subculture of the *Cocco-*

bacillus in broth was made from the first tube received from the Pasteur Institute, and after 24 hours the first series of locusts was inoculated. After 12 passages through 12 series of locusts it was found that the insects died from the disease in 8 to 10 hours. For fear of accidents a second subculture was made from one of the two remaining tubes received from the Pasteur Institute, and after 9 passages it was sufficiently virulent for field work. Every step was followed by a careful microscopical examination, so as not to run any risks. The inoculation of the locusts was more successful than the Government Analyst expected, and very few died from the injury caused by injecting the virus. The instructions issued by M. d'Hérelle were accurately carried out.

The field experiments were made near the village of Vatili in the Messaoria District, in the largest locust area in Cyprus. A piece of land bearing a crop of oats was sprayed on May 9, using 2½ litres of spraying fluid. Some cut barley and the uncultivated land adjoining were also sprayed. This land is near the Synta road, and contained a very large number of locusts. After 24 hours a few locusts were found to have died from the disease, and many were in a diseased state. As time went on the number of dead locusts found did not increase as had been anticipated, although many of the locusts had lost their activity. A microscopical examination of the liquid excrement from some of the dead locusts was made, and the *Coccobacillus acridiorum* was found in large numbers. On May 13 four litres of the virus were sprayed on a crop of wheat adjoining uncultivated land. The results here were a little more satisfactory, but it was noticed that the locusts were not attracted to the sprayed food, and it was therefore decided to add six lumps of sugar to the virus just before spraying. The third spraying was carried out on a large area of uncultivated land near the village of Lissi, and the sugar was added as decided. This spraying was most successful, and after two days many dead locusts were found. The last spraying was done at Kontea, and was very satisfactory. The sprayed areas were inspected daily, to observe the spread of the disease. Although the number of locusts attacked on the Synta road spraying grounds was small, the disease was slowly but surely spreading, and dead locusts were found at a considerable distance. A final inspection was made with the following results:

Synta road . . .	1st spraying	Fairly good.
" . . .	2nd spraying	Good.
Lissi		Very good.
Kontea		Excellent.

It was estimated that 35 to 40 per cent. of the locusts had died from the disease, and, considering the very small

expense incurred in carrying out the spraying, the result is regarded as highly satisfactory.

From the results so far obtained in different countries it seems probable that the chief value of this method of locust destruction would be to keep the insects in check and prevent them from reaching the proportions of a plague. It should be borne in mind that in time a race of locusts immune to the disease might be evolved, and M. d'Hérelle himself points out that if only a weak culture is used the insects acquire immunity.

Petroleum in Assam.—In *Mem. Geol. Surv. India* (1912, **40**, Part 1) E. H. Pascoe dealt with the oil fields of Burma (see this BULLETIN, 1914, **12**, 153). Part 2 of this volume has now appeared, and in this Dr. Pascoe gives an account of the petroleum occurrences of Assam. Although these are of much less importance commercially than the oil occurrences of Burma, it is worthy of note that exploitation by European methods was started in the Assam valley nearly twenty years before the Burma Oil Company began operations at Yenangyaung. The occurrences in the two countries are closely analogous, but whereas that in Burma has been extensively explored, comparatively little exploration has been done in Assam. In both countries the oil occurs in rocks of Tertiary age.

The petroleum localities in Assam are confined to a curved belt of country along the basins of the Brahmaputra and Surma. This belt is traceable over a distance of some 800 miles from N.E. Assam through Kachar and Chittagong to the Arakan coast, where it has a S.S.E. trend. It is roughly concentric with the trend of the Burmese oil belt, the distance between the two varying from 70 to 150 miles. Various parts of the Assam-Kachar-Chittagong-Arakan belt have been exploited in a primitive way, but there are only two properly worked fields of commercial importance, viz. those of Digboi and Bappa Pung, two localities only about a mile apart in N.E. Assam.

As bearing on the origin of the Assam oil, it is pointed out that there exists in Assam no Tertiary volcanic line corresponding to the Popa line in Burma. On the other hand there appears to be in Assam an intimate relation between the occurrences of petroleum and coal. The "compensative relationship" between the oil and the coal is emphasised as evidence of their common origin, a view which the author has previously elaborated at considerable length in Part 1, with reference to the oil fields of Burma.

Prospectors who intend to visit Assam, and do not know the country, would do well to note the obstacles that await them. "No one unacquainted with the Province can form any just conception of the obstacles to be contended with in making the most transitory survey. Transport, as soon

as one gets well into the hills, is a matter of no great difficulty; but the Nagas and Assamese along the margins of the hills and in the plain live in a state of lethargy brought about by continued fever, or by opium taken as a remedy against it, and are of little use for transport or commissariat arrangements. Roads are limited to the more inhabited parts of the plains, and footpaths are infrequent and often obliterated by the insuperable jungle, which in denseness can be matched by a very few places in the world. The best sources of exposures are the streams, up which it is usually possible to wade or paddle in 'dug-outs'; a gang of coolies to cut overhanging jungle is necessary to negotiate the smaller streams" (p. 272). These obstacles doubtless to some extent explain the fact that exploration has been less vigorously prosecuted in Assam than in Burma; and there must be many localities on the belt described by Dr. Pascoe in this memoir that have not received the attention they deserve.

RECENT PROGRESS IN AGRICULTURE AND THE DEVELOPMENT OF NATURAL RESOURCES

In this section of the BULLETIN *a summary is given of the contents of the more important papers and reports received during the preceding quarter, in so far as these relate to tropical agriculture and the utilisation of the natural resources of the Colonies, India, and the Tropics generally.*

SOILS AND MANURES

PREVIOUS investigations of the effects produced by the partial sterilisation of glasshouse soils, either by heat or antiseptics, have already been noticed in this BULLETIN (1913, **11**, 151, 677). Dr. E. J. Russell's third report on this subject is given in *Journ. Bd. Agric.* (1914, **21**, 97). It records the results obtained in applying the methods, found to be satisfactory on the experimental scale, to the soils of certain cucumber, tomato, and chrysanthemum nurseries. One of the difficulties previously encountered was that of cost, which was estimated to be about 1*s.* 6*d.* per ton of soil treated, and experiments have now been carried out, in conjunction with growers, with a view to lowering this cost. Although the work on the use of chemical antiseptics was continued, none of those hitherto tested can compare with heating for nursery work, and most of the experiments recorded are concerned with this method of sterilisation.

The experiments were carried out chiefly in commercial nurseries, a house being selected which had given a bad crop during the previous year, and the whole soil being

treated. The actual method of heating varied, but four general methods were used: (1) hot water, (2) baking, (3) high-pressure steam, (4) low-pressure steam.

(1) Hot water was run on to the soil until the top 8 in. were saturated. The results obtained by this method were inconclusive. (2) Baking appears to be the most satisfactory method for small-scale work, and, according to one grower, when the operation is carried out in conjunction with other nursery work the cost is about 5½*d.* per ton of soil treated. (3) Steaming is the method preferred by most growers, and two ways of using high-pressure steam were tried. In the first the soil was treated in a box 9 ft. by 3 ft. by 18 in., which was without top or bottom and placed on a grid of iron pipes of 1½ to 2 in. in diameter perforated with ⅜ in. holes. Steam at 40 to 80 lb. pressure was passed through these pipes into the soil for about 20 minutes. This method is suitable for the soil of cucumber borders and pot tomato plants. The second method of applying steam at this pressure was used for tomato houses, and consisted in steaming the soil *in situ* usually to a depth of 9 in., but sufficient information is not yet available to determine how deep the treatment should be carried. As it is essential that every part of the soil should attain a temperature of over 200° F., less than 15 minutes' treatment is insufficient. (4) Low-pressure steam was applied in the same manner, the soils being treated for about 30 minutes with steam at 20 to 30 lb. pressure. Another method used was to fork over the soil and then invert on it a galvanised iron tray backed by boards; steam was then blown underneath and found its way into the soil, raising the temperature to a depth of 10 in. or more. If the trays were left after the steaming had been stopped the temperature fell but slowly; in one experiment it was found to be 120° F. at a distance of 8 in. below the surface of the soil, 18 hours after the steaming had been discontinued.

The cost of the different processes of treatment, as worked out at certain nurseries, is recorded.

As a general rule, germination was found to be retarded in freshly steamed soils and the rate of growth of the young plants was also diminished; the effect was not so noticeable on light as on heavy soils or those rich in organic matter. This effect soon passes away and is more than counterbalanced by the seedlings being freer from disease than those raised on untreated soil. The results obtained in the nurseries fully confirmed those previously obtained on the experimental scale and showed that useful increases in the crop can be obtained in a commercial nursery by the partial sterilisation of the soil. The method is now being tried on a large scale.

The use of certain *Acacias* in sand-dune reclamation is discussed in "An Economic Study of Acacias" (*Bulletin*

No. 9, *United States Dept. Agric.*). For sand-dune reclamation it is essential that the plant first employed should act as a binder to the soil and at the same time give rise to an increase in the quantity of humus and so prepare the soil for a profitable crop. Certain acacias are well suited for this purpose, as they can thrive either on inland barren soils or on sand-dunes near the sea. Some of them are satisfied with only a few inches of rainfall, but as they are only half-hardy as regards frost, it is essential that the temperature should not remain below 20° F. for any length of time. In warm climates these acacias may well replace grasses as a preliminary reclamation crop. A summary is given of the reclamation work carried out in South Africa and California, with the aid of acacias; from this it appears that it is unnecessary to raise the plants in nurseries, and it is recommended to use a mixture of seeds of both shrubby and arborescent types of acacia so that the growth of the larger tanning bark and timber yielding species can be started at the commencement of the reclamation. It is suggested that *A. pycnantha, decurrens, leiophylla*, and *longifolia* should be sown in combination with certain shrubby species, such as *A. longifolia* var. *sophorae*, which will give way when the sands are fixed and forest conditions established.

An account of pot culture experiments, carried out at the Woburn Experimental Station of the Royal Agricultural Society of England, on the effect of adding lime to a soil already well supplied with that constituent but containing also an excess of magnesia, is given in *Journ. Royal Agric. Soc., Eng.* (1913, **74**, 417). The experiments have been in progress since 1909, additional quantities of lime being applied each year, and the quantity of lime has been raised from 0·83 per cent. to 4·5 per cent. whilst the magnesia present in the original soil amounted to 2·29 per cent. The addition of lime in all cases produced a marked increase in the yield of corn and straw, and the results quoted indicate that beneficial results may follow the application of lime to a soil already well supplied with this constituent but which contains an excess of magnesia.

Foodstuffs

Cocoa.—An account of cocoa cultivation in Samoa is given in "Samoanische Kakaokultur," a special supplement of the *Tropenpflanzer* for April 1914. In addition to a detailed account of methods, the administration and costs of a plantation are discussed at length. The industry is principally in the hands of natives, who first planted Criollo, but of late years European planters have introduced Forastero. The latter variety, in view of its greater freedom from disease and its prolific bearing properties,

has become popular. It readily yields hybrids with Criollo, and the Samoa cocoa of to-day is mainly a hybrid of the two varieties, in the successive generations of which the characteristics of Forastero are gradually becoming more and more pronounced. The supply of labour is a difficult problem in Samoa. Owing to the reluctance of the native for regular work, it was necessary to procure Chinese coolies, many of whom proved to be poor workmen, and difficult to manage. It is stated that the cost of a cocoa tree up to the time of bearing is 5 marks with Chinese labour, and 6½ marks with native labour. In either case, it is pointed out, the cultivation proves very remunerative; each tree brings in a profit of 1 to 2½ marks per annum during the first years of fruiting.

Coffee.—The cultivation of coffee in the Bukoba district of German East Africa is described in *Der Pflanzer* (1914, **10**, 133). The industry is chiefly in the hands of the natives, who grow, almost entirely, *Coffea bukobensis*. European planters have introduced *C. arabica*, which is now also being planted by the natives. A feature of the Bukoba cultivation is the utilisation of the banana as a shade and protection against wind for the young coffee plants. The Bukoba coffee tree grows to a height of 6 metres, and yields on the average a crop of 4 to 10 lb., but in some cases as much as 30 to 40 lb. It is stated that Bukoba is particularly free from coffee pests, the only one of note being *Stephanoderes coffeae*, Haged. Hemileia, the recent appearance of which in the Nairobi district and in Uganda has aroused interest, also occurs in Bukoba, but to a very slight extent. In the opinion of the writer the leaf disease which has in the last year caused alarm in Uganda is probably not Hemileia, but *Colletotrichum coffeae*, Massee, a disease which has not yet appeared in Bukoba.

Tea.—In an article which appeared in the *Indian Planters' Gazette* (1914, **50**, 709) attention is called to *Indigofera arrecta* as a suitable green manure for tea. Three methods of employing this plant as a green manure are possible. (1) It may be sown broadcast between the rows of tea bushes and hoed in when from 2 to 3 ft. high. (2) It may be grown as a separate crop in a field apart, and the successive crops of stems cut down and applied in shallow trenches opened out between the tea bushes. (3) It may be grown on one block of the tea plantation between the bushes, and the first crop of stems cut and applied as manure to another block, the second crop being hoed in on the block on which it grew; where this method is adopted the sites for growing the crop are reversed each year. The last-named method is said to give the best results. Where systematic green-manuring on these lines has been practised for a number of years, together with

deep hoeing and forking during the winter, even old and declining tea is said to have responded to the treatment and given flushes equal to young tea at its best. Spasmodic attempts at green-manuring are said to be of little value, and in order to obtain good results the process is best carried out on a pre-arranged working plan covering three or four years.

Wheat.—The *Rep. Agric. Research Inst. Pusa*, 1912-13, p. 26, reviews the present position of the Indian wheat investigations, and shows that wheats of the highest class have been produced to meet the requirements of the various wheat-growing districts. An important feature of the recent tests was the superiority in the milling and baking trials of the samples of "Pusa 12" from stations in the Indus Valley, *i.e.* Lyallpur, Mirpurkhas, and Gurdaspur, over those grown in the Ganges Valley. Wheat-breeding experiments are in progress to improve the best of the Pusa wheats in standing power, rust resistance, and in general hardiness. For this purpose crosses between Indian wheats of good grain quality and various English and American varieties were made in England in 1910, and two series of these hybrids are now in the fourth generation, the results so far being most promising. Experience shows the necessity of improving the standing power of Indian wheats, and this will be the object of future experiments.

Sugar.—The results of sugar-cane experiments at Tzaneen Experiment Station, in the Zoutpansberg District of the Transvaal Province, are recorded in *Agric. Journ. Union of S. Africa* (1914, **7**, 314), and are stated to be very satisfactory. "Uba," the most successful cane in Natal, and "Demerara" were the two varieties grown, and yielded 28½ tons and 19¼ tons of cane per acre respectively. The "Uba" cane yielded a juice containing 21 per cent. cane sugar, which is slightly more than the maximum figure for Natal-grown cane. The juice from the "Demerara" cane contained 20·4 per cent. of cane sugar. The results show the possibility of sugar-cane growing on the Transvaal low veld, but the question of labour and competition with the established industry in Mozambique and Natal are important factors to be considered before attempting the cultivation on a commercial basis.

Bananas.—In Fiji the ravages of the "banana borer" (*Cosmopolites sordida*, Chevr.) had grown to such alarming proportions in spite of all artificial methods of control that a mission to Java was undertaken in November 1912 with a view of discovering natural enemies of the borer which were reported to exist there and in Papua. The results of the expedition are contained in *Bulletin* No. 7, 1914, *Dep. Agric. Fiji*. The most satisfactory parasite proved to

be a *Histerid* beetle, *Plaesius javanus*, Er. The adult beetle consumed in captivity an average of 8, and the larva 33·8 fully grown grubs of the banana borer per head per day. Five thousand beetles were conveyed to Fiji in moist earth, of which number 3,792 arrived alive. Batches of 500 were distributed to seven plantations in badly infested districts, and from the fact that after a period of four months the beetles were reproducing it is considered that the climatic conditions of Fiji are suitable, and that the beetles are now probably established in the country. The transmission of beetles packed in damp moss by post from Java to Fiji was successful, and would prove a simple means of obtaining a further supply if necessary.

Oils and Oil Seeds

Castor Seed.—An account is given in the *Rhodesia Agric. Journ.* (1914, **11**, 529) of experiments made with this crop in South Africa. At the Experiment Station near Pretoria it was found that the large-seeded varieties (*Ricinus zanzibarensis*) bore larger crops than the small-seeded (*R. sanguineus* and *R. communis*). When the plant was grown as a perennial an average annual yield of about 1 lb. of seeds per tree was obtained. This yield was confirmed by subsequent trials at Salisbury, but it was found that many of the plants died during the second year. When the large-seeded varieties were treated as an annual crop (5,000 plants to the acre), a yield of only 600 lb. per acre was obtained, due to the planting being too close. Experimenters in the Hartley district, which lies at a considerably lower altitude than Salisbury, report much heavier yields, up to 3 lb. of clean seeds per tree being obtained. One farmer on the sand veld has estimated his average return at 1,000 lb. of clean seeds per acre. The oil content of the seeds grown in Rhodesia varies from 49 to 52 per cent., and is thus quite normal.

Coconuts.—In their recent work, *All about Coconuts*, Belfort and Hoyer state that "at present there is a great scarcity of land suitable for successful coconut growing" in Ceylon. According to the *Tropical Agriculturist* (1914, **42**, 330), this statement is not quite correct, as there are still fairly extensive areas awaiting plantation. A large tract was bought up recently in the Puttalam district, which goes to show that even in the drier districts the prospect is promising. It is considered that the possibilities are good in some of the more remote parts of the island, *e.g.* the Sabaragamuwa Province, while there is a good deal of land far from the recognised coconut districts awaiting enterprising planters.

The cultivation of coconuts and drying of copra are being taken up by a large Austrian company in Sumatra

(*Agron. trop.*, 1914, **6**, Pt. ii. p. 49). In the north of the Achin Province, drying plant has been erected at Aleh-Aleh, and plant is also to be erected in other places. The company has land in the isles of Nias and Simaloer, and 5,000 hectares are already planted in Langsar.

Existing coconut plantations in Antigua are in a promising condition, but some lands will need to be drained in the near future (*Rep. Bot. Station, Antigua*, 1912–13, p. 28). Experimental plots have been started to ascertain whether coconuts can be grown successfully on the abundant heavy lands of Antigua. Growers are advised to use nuts from old trees for planting, as in the experiments those from young trees failed to germinate well. Unhusked nuts from Antigua are smaller than those from Dominica and Nevis, but the difference is merely due to the thinner layer of coir on the Antigua nuts.

A mill for producing coconut oil, and capable of dealing with 65 tons of copra in 24 hours, has been working for some time in Manila (*Indian Trade Journ.*, 1914, **33**, 7). A larger mill to deal with 130 tons per 24 hours is to be established farther south, near the coconut plantations.

An illustrated article on the bud-rot disease of coconut palms in Malabar by Shaw and Sundararman is contained in the *Agric. Journ. India* (1914, **9**, 111). The coconut palm is by far the most important crop in many parts of Malabar, South Canara, Cochin, and Travancore, and the suppression of this disease is therefore of great importance. In certain districts Palmyra palms have suffered severely from attacks of bud-rot (*Pythium palmivorum*, Butl.), and during the last five years over 400,000 trees have been cut down and burned in the Godavari district alone in order to keep the disease in check. Coconut palms had not been found to be attacked to any serious extent until October 1912, when numbers of trees in all stages of the disease were observed in the neighbourhood of Calicut, and the disease has also been identified in other parts of Malabar. An unfortunate feature of the disease is the difficulty of recognising it in its early stages, and even when recognised, remedial measures are difficult. The safest plan is to destroy the tree, and active measures are now being taken to check the disease by this means. An important factor in the development of the disease is the degree of moisture. In the case of Palmyra palms, a high death-rate of trees is associated with a great humidity of atmosphere. The damp fogs prevalent during the cold months in the Godavari district are particularly favourable to the growth of the fungus.

Cotton Seed.—During the official year 1912–13, 11,073 tons of cotton seed were exported from Davangere, the ginning centre of the Mysore cotton industry. None of this was

used for sowing purposes, and it is estimated that about 10,000 tons of cotton seed are annually available for industrial purposes. In order to utilise the cotton seed available, an oil mill is to be erected in the State of Mysore, either at Davangere or at Haribar (*Indian Trade Journ.*, 1914, **33**, 211). The Mysore Government has promised to take shares to the extent of half a lakh of rupees, provided the balance is subscribed by the public.

Ground Nuts.—In continuation of the work done in Montserrat in previous years with ground nuts, a comparative test of five varieties has again been made (*Rep. Bot. Station, Montserrat*, 1912-13, p. 13). The best yield was obtained from the Gambia variety, which gave 1,236 lb. of dry nuts per acre. The average yield of this variety over four years has been 1,570 lb. of dry nuts per acre, and it is thought that the cultivation of the ground nut on an estate scale would probably not be very remunerative. Its cultivation on the lighter lands in rotation with cotton might, however, be worth considering, and a good deal might be done by small growers for the purpose of local consumption and for inter-island trade. Samples of Gambia and other varieties of ground nuts grown experimentally in Montserrat have been examined at the Imperial Institute, and the results of their examination and commercial valuation were published in this BULLETIN (1913, **11**, 578).

According to the *Rhodesia Agric. Journ.* (1914, **11**, 513), the British South Africa Company is about to erect an oil mill at Salisbury, Southern Rhodesia, principally for the crushing of ground nuts. Sunflower seed and possibly linseed and castor seed will also be treated. It is stated that farmers situated on the sand veld will possibly make ground nuts a staple crop in place of maize. The production of oil-cake in that district will be a great boon to dairy farmers and stockmen generally.

Oil Palm.—The oil palm was introduced into Ceylon at Peradeniya in 1850 (*Trop. Agriculturist*, 1914, **42**, 178), but the small number of trees now growing there have only produced a few seeds at this elevation (1,650 ft.). Seeds from these trees have been sown, and 5,000 seeds are being obtained from Africa for trials at the new Anuradhapura Experiment Station, as it is considered that the oil palm may prove suitable for cultivation in the low country of Ceylon.

According to Chevalier (*Journ. d'Agric. trop.*, 1914, **14**, 112), the oil palm has only been grown as an ornamental tree in Indo-China up to the present time. A number of trees were examined by him in various parts of the country during his recent mission to Indo-China, and he considers that the tree is likely to become important to planters, as it seems to thrive as well there as in West

Africa. Although the palms bear fruit of good quality, the number of bunches is smaller than in Africa, and the fruit heads are of smaller dimensions; this is probably due to the trees not having received sufficient care. The small number of developed fruits in the bunches and the larger number of aborted fruits appear to be caused by lack of fertilisation, which may be due to the absence of strong winds or of certain insects which assist fertilisation, but is more probably due to the fact that the oil palms are widely distant from one another, and are consequently unfavourably situated for cross-pollination. According to Chevalier, the male and female flowers on the same tree mature at different times, and cross-fertilisation is therefore essential to the formation of fruits.

In Sumatra the oil palm has only been worked on an insignificant scale by natives up to the present time (*Agron. trop.*, 1914, **6**, Pt. ii, p. 49); but it is now attracting the attention of capitalists, and it seems likely that its cultivation and exploitation may become a matter of importance.

The oil palm is very abundant in the Stanleyville district, Belgian Congo, between Ponthierville and Kindu (*Dipl. and Cons. Rep. Ann. Series*, No. 5260 [Cd. 7048–77], 1914, p. 21). Its exploitation should attract the attention of merchants, as large quantities of oil appear to be obtainable from the natives.

Candelilla Wax.—The *Bd. of Trade Journ.* (1914, **85**, 285) states that a ten-years' contract has just been granted by the Mexican Government for the exploitation of the candelilla plant over an area of 100,000 hectares (about 247,000 acres) situated in the States of Durango, Zacatecas, and Coahuila.

Miscellaneous.—It is stated in the *Monthly Rep., Cent. Econ. Bd., Sudan*, March 1914, p. 40, that in consequence of the very high price of sesamum seed, experiments are being made at the soap factory at Singa, Sudan, in the extraction of oil from the "lalob" seed, *Balanites aegyptiaca*. For the results of examination of these seeds and of the oil yielded by them, see this BULLETIN (1908, **6**, 364).

An article is quoted in the *W.I. Agric. News* (1914, **13**, 148) which calls attention to the popularity in the American markets of three new edible nuts, the best known being the "pili" nut of the Philippines. Pili nuts of commerce are apparently derived from fruits of *Canarium ovatum* and *C. luzonicum* of the Philippines, and to a slight extent from *C. commune* of the Dutch East Indies. The second kind is the "paradise" nut grown in Brazil, Venezuela, and Guiana, and closely allied to the Brazil nut. It is stated to contain as a rule about 39 per cent. of oil. The third nut referred to is the "Queensland" nut, *Macadamia ternifolia*. Small shipments made from Queensland to London

are said to have brought 12*s.* per lb. at Covent Garden Market.

Essential Oils

Camphor. — On behalf of the Monopoly Bureau of the Government of Formosa in connection with the camphor industry, two oils derived from trees resembling *Cinnamomum camphora* have been examined (*Perfumery and Essential Oil Record*, 1914, **5**, 244). The trees are known locally as Shô-Gyū and Yu-Ju, and have not yet received botanical designations. The Shô-Gyū tree yields from 1·3 to 3 per cent. of oil, with specific gravity varying from 0·900 to 1·031 at 15° C. and optical rotation from + 7° 75′ to + 34° 45′. The following constituents have been identified in the oil: formaldehyde, sabinene, dipentene, α-terpinene, γ-terpinene, terpineol-4, geraniol, citronellol, safrole, and eugenol. The Yu-Ju tree yields from 3 to 4 per cent. of oil, having a specific gravity varying from 0·942 to 0·967 at 15° C.; optical rotation + 18° 8′ to + 30° 8′. In addition to camphor and considerable quantities of cineole the following constituents have been identified in the oil: furfurol, α-pinene, β-pinene, camphene, dipentene, α-terpineol, safrole, and eugenol. It is estimated that Formosa could produce approximately from 1,092,000 to 1,170,000 lb. of Shô-Gyū oil, and from 65,000 to 78,000 lb. of Yu-Ju oil annually.

Hop Oil.—By examining the physical and chemical properties of the oil, F. Rabak has sought to differentiate between hops derived from various geographical sources (*Journ. of Agric. Research*, 1914, **2**, 115). The result of his experiments show that the source of hops may be indicated by the ester value of the oil; it is not yet possible to state definitely, however, whether the proportion of esters in the oil has any definite relation to the quality of the hops.

Oil of Phoberos cochinchinensis.—Messrs. Roure-Bertrand Fils (*Bulletin*, April 1914, p. 7) have examined a sample of oil of *Phoberos cochinchinensis*, Lour., distilled in Annam. The oil possessed an odour resembling that of sweet orange of Portugal, and was considered of value for perfumery purposes. The leaves and green stems yielded about 0·09 per cent. of oil which possessed the following constants: specific gravity at 15° C. 0·9042, optical rotation + 3° 2′, acid value 2·5, ester value 51·1, acetylation value 127·9.

Rubber

Hevea brasiliensis.—Experiments by Ruys (*Le Caoutchouc et la Gutta-Percha*, 1914, 11, 8317) show that it is advantageous to plant heavy seed. Groups of seed of different weights were planted with the following results:

	Number of seeds.	Total weight. *Grams.*	Number germinated.	Average height of stems after 20 weeks' growth. *Centimetres.*
1	24	141·5	20	65·5
2	24	116·5	18	55·5
3	24	86·5	13	42
4	24	42·5	4	24

No seed under 4 grams in weight should be planted.

The methods of working rubber plantations in Cochin China, where large areas of land suitable for Hevea cultivation exist, are described by Girard in *Bulletin Econ. de l'Indo-Chine* (1914, **17**, 47). The yields of rubber in the dry season instead of being less than those obtained in the rainy season, as is the case in many other countries, may be as much as 50 per cent. greater. The Annamite labourers are particularly dexterous, and on the average each man taps 600 trees per day, while women can tap 450 trees per day. After making a number of experiments, and studying the methods of tapping used in Malaya and other countries, the following method has been found most suitable for Cochin China: one-fifth of the circumference is tapped with three fine cuts (1 millimetre wide) at an angle of 15°, separated from one another by a distance of about 22 in. The cuts are reopened daily, and it takes about a year to tap one-fifth of the circumference. This method yields a constant flow of latex with a minimum amount of bark removal. Further experiments are being made.

A useful article on the tapping of Hevea has been contributed by Cayla to the *Journ. d'Agric. Trop.* (1914, **14**, 73, 161) in which the results of all the more important experiments carried out during recent years are summarised.

A fungus attacking the leaves of Hevea trees in Surinam is described by Kuyper and named by him *Fusicladium macrosporum* (*Trop. Agriculturist*, 1914, **42**, 268). It is probably the same fungus which attacks Hevea in Brazil and which has been named *Dothidella Ulei*. Young trees in the nurseries are most liable to attack, but Kuyper says that 6-year-old trees may succumb to repeated attacks. Old trees which have been attacked frequently should be destroyed, while Bordeaux mixture may be used in less severe cases. The disease exists in three forms: the first two forms attack the leaves and produce holes in them or cause defoliation; the third form attacks the stems and leaf-stalks and produces swellings which may form canker-like patches.

Chèneveau and Heim give the results of comparative tests on vulcanised rubber prepared from smoked and unsmoked Hevea crêpe made in Indo-China and from fine hard Para (*Bulletin de l'Off. Col.*, 1914, **7**, 154). The results

given by the smoked crêpe were superior to those yielded by unsmoked crêpe and similar to those given by the fine hard Para. In this investigation all the samples were vulcanised for the same period of time, whereas it is necessary in such work that the optimum time of vulcanisation for every specimen should first be determined.

Landolphia spp.—Jumelle and Perrier de la Bathie have published (*Le Caoutchouc et la Gutta-Percha*, 1914, **11**, 8173) a paper on the rubber of *Landolphia Mandrianambo*, Pierre, a large rubber vine occurring in the eastern part of Madagascar. The character of the rubber is liable to great variation, which was found to depend partly on the age of the tree and the locality where it was grown, and largely to the differences existing in the latex furnished by different tissues of the stem; the phloem was found generally to yield a rubber of good physical properties free from tackiness, while the other tissues, such as the cortex, pericycle, and pith, yielded viscous non-elastic products.

Manihot spp.—In connection with the crisis in the German East African Manihot rubber industry caused by the present low prices of rubber, Marckwald and Frank call attention (*Der Tropenpflanzer*, 1914, **18**, 216) to the desirability of exporting Manihot rubber in ball form in a moist condition and not as dry washed crêpe or sheet. The low price which Manihot rubber commands appears to be largely due to the uncertain results which it gives when vulcanised; samples of the rubber in form of sheet or crêpe of good appearance frequently give very poor results on vulcanisation. According to the authors the washing of Manihot rubber in Africa previous to export renders it very liable to oxidation with consequent loss of "nerve." In support of their recommendation to export in moist form, they quote the fact that moist rubber from South Kamerun packed in barrels sells by name without sample, and realises about 1*s.* 10*d.* per lb. (March 1914).

Miscellaneous.—It is reported (*Board of Trade Journ.*, 1914, **85**, 50) that a company has been formed to exploit *Euphorbia Drageana*, E. Mey., in Namaqualand. The latex is said to yield a product containing 70 per cent. of resin and 17·6 per cent. of rubber. The company has a concession of about 220 sq. miles, on which there are about 6,000,000 plants.

Fibres

Silk.—In the *Rep. Agric. Dept., Bengal, for the year ending June* 30, 1913, an account is given of a new scheme which has been devised with the object of reclaiming the silk industry. The aim of the scheme is gradually to establish throughout the silk districts a sufficient number of central nurseries with rearing houses

and thus enable the whole of the seed cocoons required in the province to be supplied under Government supervision. It is believed that this is the only really effective method of dealing with the problem. A number of the existing smaller nurseries were closed during the year and others are being converted into enlarged and improved central nurseries with rearing houses complete. The ultimate success of the scheme depends largely on the willingness of the rearers to pay an adequate price for pure seed.

A short account of the silk industry of Madagascar is given in *Journ. d'Agric. Trop.* (1914, **14**, 89). The natives of the centre of the island obtain silk both from the native silkworm or "landibe" (*Borocera madagascariensis*) and also from the mulberry silkworm (*Bombyx Mori*), which was introduced about seventy years ago. The "landibe" lives in natural forests of *Uapaca clusiacea* or in artificial plantations of *Dodonea madagascariensis* and *Cajanus indicus*. It gives two harvests a year; the cocoons are brown or grey, and the silk cannot be reeled, but is carded and spun. The cocoons are an important article of internal trade. The silk is comparable with the tussah variety, and by the adoption of appropriate measures the production could be considerably increased. The mulberry silkworm is cultivated in the vicinity of Antananarivo, Antsirabe, and Ambositra, and the number of rearers shows a continuous increase. The silk is not yet being exported, but is used locally. As it is considered that sericiculture is an interesting domestic industry which might be of value in improving the material condition of the natives of the centre of the island, great efforts are being made to develop it. The races cultivated were introduced from Europe, but they have adapted themselves to the local conditions and become polyvoltine, five generations being produced annually. The Nanisana Station is devoted to the study of the silkworm and the production of disease-free seed; it distributes annually about 300,000 layings of carefully selected silkworm eggs and 250,000 mulberry plants.

Paper-making Materials.—Attention has been drawn in this BULLETIN (1913, **11**, 163) to the value of the stems of *Hedychium coronarium* from Brazil for paper-making. An account is given in the *Kew Bulletin* (1914, No. 4, 165) of an examination by Messrs. Clayton Beadle and Stevens of dried specimens from Calcutta. This material furnished a good, strong, elastic paper which would be serviceable as a wrapping paper. It is considered probable that *Hedychium coronarium* will be found to possess good paper-making qualities from whatever part of the world it is obtained. The Indian product gave slightly different results from that from Brazil, but this is attributed to differences in the preparation of the raw material prior to

shipment rather than to any actual difference in the plant itself. On p. 175 of the same publication reference is made to the results of experiments in planting *Hedychium coronarium* in British Guiana. The first trials failed on irrigated land, but on the tidal parts of the rivers above the brackish-water sections the plant grew well on swampy land and yielded stems 6 ft. 6 in. long as compared with a length of 2 ft. 6 in.–3 ft. on dry soil.

In *Der Pflanzer* (1914, **10**, 202) reference is made to a report of the German Consul at Merida, Yucatan, Mexico, which states that a company has been established in Mexico for the manufacture of paper from the refuse of the henequen (Sisal hemp) industry. A large quantity of henequen stumps and leaves has been tested in a paper-mill in New Orleans and the material has been found to yield a very strong paper. It is estimated that from 15 to 20 million henequen stumps are allowed to decay every year, and, in addition to these, there is the enormous mass of leaf-refuse obtained in extracting the fibre. A mill is to be erected in Yucatan capable of working up 15 to 20 tons of the raw material per day. The work will be restricted at first to the manufacture of half-stuff for export. If this project proves successful, it will be of considerable importance to the Sisal hemp industry.

Cotton

Egypt.—Reference to the cotton industry of Egypt is made in the *Reports by H.M. Agent and Consul-General on the Finances, Administration, and Condition of Egypt and the Sudan in* 1913. The crop yielded an excellent first picking, but the second picking was somewhat poor owing to the exceedingly low flood. It was anticipated that the estimated crop of 7,554,000 kantars (1 kantar = 99·05 lb.) would be approximately realised. The total area planted was 1,723,094 feddans (1 feddan = 1·038 acres) as compared with 1,721,815 feddans in 1912. The areas planted with the different varieties were as follows: Mitafifi, 623,737 feddans; Ashmouni, 356,485 feddans; Yannovitch, 173,439 feddans; Sakellaridis, 247,292 feddans; Nubari, 201,137 feddans; Assili, 65,958 feddans; Abassi, 37,383 feddans; Voltos and other varieties, 17,663 feddans. The quantity of cotton seed distributed by the Government amounted to 90,096 ardebs (1 ardeb = 5·44 bushels) as against 42,273 ardebs in 1912. Cotton-breeding experiments have resulted in the production of four new strains, and it is hoped that by further experiments an early maturing cotton will be obtained which can be harvested before the boll-worm has time to hatch. At thirty-eight demonstration farms endeavours have been made to show the small farmer how to cultivate more intelligently and economically with the

means and labour at his disposal. In order to check the over-watering of the soil, the unduly large discharge outlets from the canals have been replaced by pipes of varying dimensions, according to the size of the area to be served. The efforts to check the ravages of the cotton worm have been continued with considerable success. Reference is made to the alarming increase of the pink boll-worm (*Gelechia gossypiella*) and to the measures undertaken for its control (compare this BULLETIN, 1914, **12**, 312).

Sudan.—An account of the progress of cotton growing in the Sudan is given in the *Secretary's Annual Report for* 1913, *Central Economic Board, Sudan Government* (No. VII). The principal points of interest are that work has been commenced on the Gezira Irrigation Scheme; that almost the whole of the cotton is now ginned before export; that the importation of cotton seed from Egypt has been prohibited in order to guard against the introduction of the pink boll-worm, the Sudan being thus compelled to depend on home-grown seed in future; and that both Egyptian and long-stapled American cottons have been grown experimentally at Tokar with great success from acclimatised seed. The exports in 1913 amounted to 2,318 tons of ginned cotton, 39 tons of seed-cotton, and 4,785 tons of seed. The total value of the exports was somewhat greater than in 1912, although the quantity was rather less. The sources of the cotton and the proportion derived from each were as follows: Tokar, 72 per cent.; Khartoum district and Nile Valley north of Khartoum, 17 per cent.; Tayiba, 7 per cent.; other cotton, mostly rain or flood-grown, 4 per cent. The better grades of Tokar cotton realised higher prices than "fully good fair" Egyptian, but the later pickings showed considerable deterioration, which was partly due to the prevalence of the Asal fly. The native cultivators of the better class are now showing keen interest in the use of labour-saving implements and have used the plough for the first time, ploughing more than 500 acres. Experiments at Tokar with seed of Egyptian Mitafifi and King's and Sunflower American varieties, all of which had been acclimatised for two seasons, showed improved germination, earlier production, and larger yield, and the crop exhibited no deterioration in staple. The American kinds give larger crops than the Egyptian, and it is considered that when the rainfall is about 100–110 mm. the American type is the more suitable. Great interest is being taken in the crop by the natives of the Kassala Province, and the crop for 1913 amounted to about 343 tons of seed-cotton. In the Blue Nile Province there is not much Egyptian cotton grown except at the Tayiba Farm; this is due to the fact that, owing to the very small rainfall, satisfactory results cannot be expected. Similarly in the Berber Province the

natives are disinclined to grow Egyptian cotton except on land artificially irrigated. On the Zeidab Estate the best results were obtained with the Sakellaridis and Nyasaland varieties.

India.—The Report of the Imperial Cotton Specialist (*Report of the Agric. Res. Inst. and Coll., Pusa, for* 1912–13, pp. 93–119) contains interesting information on the progress made in the improvement of cotton growing in the various Provinces of India. In the North-West Frontier Province the local variety is so productive and so well suited to the country that it is considered undesirable to replace it by any other kind. This cotton consists of a mixture of varieties of the *G. neglectum* type, and it is recommended that efforts should be made to improve it by selection.

In the Punjab a number of varieties have been grown on the Lyallpur Farm for several years, and their suitability for the local conditions has been thoroughly established. It is thought that the most promising of these should now be subjected to selection and multiplication with a view to distributing them to cultivators. It is pointed out that only one variety or type should be introduced into each tract or district, as otherwise complaints will be made by buyers that the cotton is of mixed quality and the cultivators will suffer in consequence.

In the United Provinces encouraging results have been obtained with American cottons, but data have not been furnished hitherto to prove that they are really profitable to grow. Experiments are in progress in connection with the indigenous varieties.

In the Central Provinces the hardy indigenous varieties are now giving such satisfactory crops, and furnish a product so well adapted to the needs of the market, that there is no incentive to grow longer-stapled cottons, and especially so as the latter do not seem well suited to the local conditions of soil and climate.

In Madras experiments at the Nandyal and Hagari Experimental Stations have demonstrated very clearly that a rapid deterioration takes place, even in Indian cottons when their environment is changed, and show that fresh seed of such varieties must be continuously imported. This is particularly the case with the Broach seed introduced into the cotton districts by the seed farm at Hagari. At the Nandyal Station types of cotton have been produced which, in point of yield and ginning percentage, are 10–20 per cent. superior to Kumpta and 30–40 per cent. to Westerns. The introduction of Cambodia cotton into Madras was at first attended with excellent results; the cotton was grown on good soil with well irrigation, the land was thoroughly ploughed, and special attention was

paid to the cultivation. Recently, however, the cotton has been planted on any land and only roughly cultivated, and the fields have been found to contain a considerable proportion of plants of the Uppam and Karunganni types. As a result, the quality of the Cambodia cotton has suffered, and if steps are not taken to keep the type pure and free from the local varieties, the product will fall in value to the level of the ordinary native kinds.

In Bombay some interesting results have been obtained at the Dharwar, Gadag, and Nadiad Farms. At Dharwar Broach cotton has shown a continuous deterioration to the local Kumpta type, and it is considered that in order to maintain the character of this cotton, the seed must be renewed over the whole area once in every three years. Selection of the Kumpta cotton has been continued, and hybridisation experiments have led to the production of several promising hybrids. Cambodia cotton has proved unsuited to the conditions of Dharwar. The Dharwar American cotton is said to have suffered deterioration, and this is probably due to the admixture of a superior with an inferior type. In the Ahmedabad District Cambodia was grown with success and reached higher prices than the local Lalio cotton. It is regarded as probable, however, that the Lalio variety will not be readily displaced by Cambodia, as the latter is more delicate and more susceptible to frost and insect pests.

In connection with experiments on the improvement of the cotton of the United Provinces which have been in progress during the last ten years, an interesting and well-illustrated account of that part of the work which deals with the vegetative characters has been given by H. Martin Leake and Ram Prasad in the *Memoirs of the Dept. of Agric. in India, Botanical Series* (1914, **6**, No. 4). It is shown that the vegetative characters are of considerable indirect importance in relation to the cotton crop. The habit of the plant is largely dependent on the method of branching, and on this habit depend such vital points as the suitability of the plant for field cultivation and the yield of seed-cotton per acre.

It is stated in the *Rep. Dept. Agric., Burma, for the year ended June* 30, 1913, that a crop grown at Tatkon yielded 1,200 lb. of seed-cotton per acre, although it had been severely attacked by insect pests which stained the fibre and consequently reduced its value. The product was examined at the Imperial Institute and found to be of fairly good quality, and decidedly superior to the local indigenous varieties. The cultivation of this cotton is being encouraged. Cambodia cotton can be grown on the higher soils in Lower Burma with good results in respect of both yield and quality; the seed should be sown in August or September. Good cotton has also been grown on a rubber plantation in the

Henzada District, and seed has been distributed to several rubber plantations in Pegu and Hauthawaddy. The cultivation of tree cotton in Tenasserim has been continued.

West Indies.—An account of the progress of the cotton industry in Antigua and Barbuda is given in the *Rept. on the Botanic Station and Experiment Plots, Antigua*, 1912–13. In Antigua 800 acres were planted in 1912–13 as compared with 433 acres in the previous year, and yielded 197 lb. of cotton per acre, this being the largest return per acre hitherto secured in the island. The whole of the cotton was of the Sea Island variety. Some damage was caused by leaf blister mite (*Eriophyes gossypii*) and caterpillars (*Alabama argillacea*). In Barbuda 130 acres were devoted to the crop, and yielded 230 lb. of cotton per acre. No serious attacks of insect pests were experienced.

DRUGS

Belladonna.—Experiments carried out by A. F. Sievers to determine the distribution of alkaloids in the various parts of the belladonna plant are recorded in the *Amer. Journ. Pharm.* (1914, **86**, 97). The determinations were carried out on four third-year plants in full bloom, and six first-year plants after flowering, when nearly all the berries were ripe. The following average percentages of alkaloids were obtained: In the third-year plants the flowers gave 0·385; flowering tops, 0·865; leaves, 0·475; stems, 0·292; roots, 0·448; entire plant, 0·444. In the first-year plants the leaves gave 0·686; young sprouts, 0·9315; fruit, 0·3192; stems, 0·1145; roots, 0·4605; entire plant, 0·343 per cent. These results agree with the observations of Gerard (*Year-book of Pharm.*, 1880–81, p. 482) as to the proportion in which the alkaloids are distributed among the various parts of the plant. The percentage of alkaloids in small young leaves, stems, and roots was found to be greater than that in the same parts of the plant when larger and older. In further experiments seven four-year-old plants were dug up, their roots divided into bark and wood, and the amount of alkaloid in each part determined. It was found that in each case the wood was richer in alkaloid than the bark. Analyses were also performed on the leaves of various species of *Datura*, and it was found again that small young leaves were richer in alkaloids than older and larger leaves. The author points out that his experiments indicate that all parts of the belladonna plant, except the large woody stems, contain enough alkaloid to render their utilisation practicable.

Indian Hemp (*Cannabis indica*).—The *Official Gazette of the East Africa Protectorate* (1914, **16**, 571) contains a Government notice (No. 100 of 1914), which lays down certain

rules to be observed in the East Africa Protectorate under the Abuse of Opiates Ordinance, 1913, section 18. These rules declare it illegal to sow, cultivate, or otherwise grow Indian hemp (*C. indica*) in the Protectorate, under penalty of imprisonment or fine, and authorise any police officer or village headman to destroy any growing plants.

FORESTRY: FOREST PRODUCTS

Shade Trees for Tea and Coffee.—In an article contributed to the *Planters' Gazette* (1914, **50**, 707) the writer gives the following as qualities that an ideal shade tree should possess: It should be a quick grower; its leaves should be small so as to cast a light but even shade, and to enable them, when they fall, to pass between the branches of the tea or coffee bushes on to the soil; it should not produce a heavy drip, which would injure the crop, and it should not exhaust the soil, but, rather, should enrich it by adding leaf-soil or by fixing atmospheric nitrogen. The last-named property is possessed by trees belonging to the natural order Leguminosæ. The two leguminous trees that are said to be the most suitable for use in India as shade trees for tea or coffee are the sau of Assam (*Albizzia stipulata*) and the sishum (*Dalbergia Sissoo*), the latter being the better. Both species are rapid growers, and supply a light shade and good leaf-mould. The sau is, however, liable to be damaged by winds. The sishum is described as a strong grower, with wide-spreading branches clothed with small leaves that are shed profusely; the timber is of good quality, and is employed both for building and for furniture. When once established sishum requires little care and hardly any pruning during the first ten or fifteen years. Sishum trees grow in many parts of India, and seeds are readily procurable. The methods of cultivation are stated to be as follows: Seeds are sown at the commencement of the rains in lightly dug nurseries, and the seedlings, when about a year old, are planted out about 20 ft. apart between the rows of tea. After about ten or fifteen years, if the trees are found to be crowded, every alternate one is cut out.

Timbers

Indian Timbers for Matches.—In an article on the Indian match industry which appeared in the *Indian Agriculturist* (1914, **39**, 55), the woods of the following species are said to be employed in Burma for match splints: *Bombax insigne*, *B. malabaricum* (simul), *Anthocephalus Cadamba* (kadam), *Sarcocephalus cordatus*, *Spondias mangifera* (amra), and *Engelhardtia spicata* (palash). These woods are not the best for the purpose, but are those most easily procurable.

There are other kinds of white wood, such as poplar, pine, willow, and alder, in abundant quantities, but they are difficult to extract and transport, and are therefore costly. Until recently the bulk of the supply of matches used in India has come from Norway and Sweden, but Japanese matches now enter the Indian market. The matches made in Japan are inferior to those of European origin, but they are able to compete successfully with the latter owing to their cheapness.

The attempts to manufacture matches in India have not hitherto been attended with great success, but recently two well-equipped factories have been started in Burma which give promise of good results. One of these is in Rangoon and is owned by Chinese; the other is at Mandalay, and is under European management.

Further investigations are said to be necessary in order to settle the question as to the most suitable woods to employ, and when these have been brought to a satisfactory conclusion it is thought that Burma will be able to produce matches of first-class quality.

Tanning Materials

"Pine" Bark (*Callitris* spp.).—It has been suggested that an investigation be undertaken to deal with the question of the commercial utilisation of the bark of the so-called pine trees of Australia (*Journ. Soc. Chem. Indust.*, 1914, **33**, 232). The two species most frequently met with are *Callitris calcarata* and *C. glauca*. Their barks contain, on an average, 20·9 per cent. and 12·3 per cent. of tannin respectively, and although when used alone they impart a deep red colour to the leather tanned with them, they can be used satisfactorily in admixture with certain other tanning materials. There are large areas under these trees in Australia, and it is considered that the profitable exploitation of the barks will depend on their successful manufacture into extract, for which a likely market will be found in Australia, as that country, at the present time, imports large quantities of wattle bark from South Africa.

Wattle Bark.—Preliminary experiments carried out in 1911–12 to destroy the bagworms which have proved so injurious to wattle plantations (cf. this BULLETIN, 1914, **12**, 148) have shown that this pest can be controlled by means of a parasitic fungus (*Rep. Dir. Agric. Union S. Africa*, 1912–13, p. 181). Recent experiments have been made in which the fungus was distributed by suspending from the trees fungus cultures in linen bags, through which the culture develops as soon as the climatic conditions are suitable. Results have shown that this fungoid infection of bagworms depends largely on the time of the rainfall. Early rains are favourable to the infection; but if the rains

are after the feeding time of the young bagworms, little or no infection takes place. Further trials with a modified method of propagation are being carried out this season.

Investigations are also being carried out in the Union of South Africa on the "gumming" of wattles (*Acacia mollissima*) (*loc. cit.*, p. 178.) This disease, which is prevalent in Natal, first appears as dark, sunken spots on the stem; later, cracks appear in these spots and gum exudes. If the gumming is not too severe, a cambium may form and the wound heals; but if the conditions favourable to gumming again prevail, gum may exude from the same spot. In this way the vital processes of the tree are greatly interfered with, and if the gumming continues the tree ultimately succumbs. No bacteria or fungoid organism could be isolated from the gum spots, and it would appear that the cause is probably due to some physiological disturbance. The gum forms in the phloem of the stem, the gum pockets being situated around the hard bast fibres.

The quantity of wattle bark exported from the Union of South Africa during 1913 was 65,052 tons as compared with 52,776 tons in 1912 (*Ann. Rep. Trades Commr., Union of South Africa*, 1913, p. 40). The demand for this material in the United Kingdom has remained almost stationary, but in Germany it has gradually risen owing to the increased production of leather in that country.

Enquiries made by the Trades Commissioner have shown that in order to safeguard the future of the wattle industry in Natal it is necessary that a part of the supply of bark should be manufactured into extract, so that an increased outlet for this tanning material may be found in the markets of the United Kingdom, Russia, the United States of America, and possibly France. A solid wattle extract containing 20 per cent of moisture and from 62 to 63 per cent. of tannin, it is stated, would fetch a higher price than quebracho extract.

In this respect it is interesting to note that according to the *Board of Trade Journal* (1914, **85**, 435) a company has been formed in Maritzburg for manufacturing wattle extract in solid form. It is estimated that the cost of installing the necessary plant will be £20,000 and the cost of dealing with 6,000 tons of raw material per annum £3,000.

Resins

Turpentine.—Experiments in tapping "Chil" pines (*Pinus longifolia*, Roxb.) have been continued in the Punjab (cf. this BULLETIN, 1913, **11**, 361), and have confirmed the results of the previous year, and proved that the short freshening period (*i.e.* the interval between two successive tappings) is economically sound. In future, therefore, the

four days' period, at present in vogue, will be the standard freshening period (*Prog. Rep., For. Admin., Punjab*, 1912–13, p. 11). This period has the advantage of not requiring an excessive labour supply, nor does there result a wound of inconveniently great length.

The resin factory at Shahdara (*loc. cit.*, p. 12) has been worked continuously throughout the year and dealt with 10,000 maunds (367 tons) of crude oleo-resin. It is proposed to carry on the resin industry by departmental agency until such a time as the best method for producing marketable turpentine oil and colophony has been ascertained.

Experiments have also been carried out in tapping "Kail" pines (*P. excelsa*, Wall.) in Bashahr. The results obtained were not very satisfactory, as the yield of oleo-resin was relatively small as compared with that from "Chil" pines, while the cost of extraction of the crude oleo-resin from the comparatively remote "Kail" areas of Bashahr raised the cost of production of "Kail" turpentine oil and colophony to a high figure. Accordingly these experiments have been stopped and the "Kail" areas will not be worked for the present. A small quantity of turpentine oil and colophony from this source was manufactured, and an excellent grade of turpentine oil, nearly equal in quality to the best American, was produced. An account of the results of the examination of the oil at the Imperial Institute was given in this BULLETIN (1912, **10**, 544).

The results of an investigation of the oleo-resin of *P. Khasya* and *P. excelsa*, carried out at the Forest Research Institute, Dehra Dun, are given in *Indian Forest Bulletin*, No. 24, 1913. The results confirm those of previous investigations and indicate that the oil obtained from the oleo-resin of *P. Khasya* from Burma is equal in quality to high-grade French and American turpentine oils (cf. *Technical Reports and Scientific Papers, Imperial Institute*, 1903, p. 167), while the oil of this species from Assam is of inferior quality and only equal to the lower grades of American oil (cf. this BULLETIN, 1912, **10**, 544). The oil of *P. excelsa* is equal to the best grades of American and French oils (*loc. cit.*). The yield of oil in the case of the *P. Khasya* oleo-resin from Burma was 17·8 per cent., and in the case of *P. excelsa* from the United Provinces 18·8 per cent. No definite information is available as to the areas covered by these two species in Assam and Burma, but the area under *P. Khasya* in Assam appears to be quite negligible. It is thought that the only part of Burma likely to prove suitable for the establishment of turpentine distilleries is the Southern Shan States; in view of the high quality of the oil yielded by the Burma pines, it is suggested that a complete economic survey of the pine area in these States should be undertaken.

Further results of the investigation which is being carried out on the possibilities of utilising the pines of Western United States of America as sources of commercial turpentine oil (cf. this BULLETIN, 1913, **11**, 361, 696) are published in the *Journ. Indust. and Eng. Chem.* (1913, **5**, 971). The oleo-resins from the single-leaf pine (*Pinus monophylla*, Torr. and Frem.) and from *Pinus Jeffreyi* have been examined as to their chemical constituents. The former gave 19·0 per cent. of volatile oil, consisting chiefly of *a*-pinene and 80·0 per cent. of colophony, while the latter yielded 88·0 per cent. of colophony and 10·0 per cent. of volatile oil, consisting mainly of normal heptane.

ECONOMIC MINERALS

Amblygonite.—In *Bulletin* No. 53, 1914, *Geological Survey of Western Australia*, T. Blatchford deals with the area embracing the Burbanks and Londonderry mining centres, and refers to an occurrence of amblygonite. The rocks of the area are largely greenstones (amphibolite, etc.) traversed by intrusions of granite and porphyrite, and dykes of pegmatite. The alluvial deposits, quartz reefs, and acid dykes of the area are auriferous. The mineral amblygonite has been mined at a locality about two miles north of Ubini, a railway siding on the Coolgardie-Perth railway. It occurs as a constituent of a dyke of pegmatite, associated with topaz, lepidolite, and beryl. It gave on analysis: phosphoric acid 48·01, alumina 34·71, lithia 9·31, fluorine 6·95, and water 2·70 per cent. Exact measurements of the dyke in which the mineral occurred were not obtainable, but it probably does not exceed a few feet in thickness. A parcel of three tons, of which a bulk sample showed 46·49 per cent. of phosphoric acid and 8·67 per cent. of lithia, was exported to Germany and sold at £8 3*s.* 11*d.* per long ton.

Bismuth Ore.—In *Bulletin* No. 14, 1913, *Geological Survey of Tasmania*, dealing with the Middlesex and Mount Claude Mining Field, W. H. Twelvetrees gives an account of the bismuth, tin, and tungsten mines of that area. The stratified rocks of the area are described as belonging to the pre-Cambrian, pre-Silurian, Silurian, Tertiary, and Quaternary. The igneous rocks include an early "porphyroid group," intrusions of granite of Devonian age, and plateau basalts of Tertiary age. It appears to be with the Devonian granites that the ore deposits are genetically connected. In this granite, and also in veins traversing the aureole of surrounding sedimentary rocks which have been metamorphosed by the intrusion, there occur ores of bismuth, tin, tungsten, and molybdenum. Various auriferous and argentiferous galena and zinc blende deposits occur still farther removed from the intrusion, and it is considered

that these represent the "hydatogenetic" phase of deposition in connection with the granite intrusion, whereas the tin-tungsten-bismuth deposits occurring in the granite and the contact zone represent the "pneumatolytic" phase.

It appears that there has not been much erosion of the ore-bearing granite and the surrounding contact zone. The Government Geologist therefore concludes that the mines are in the ideal zone for ore-deposition, and that, so far as can be ascertained on geological grounds, they have reasonable prospects in depth.

None of the mines in the district are very large, but they are being worked successfully. Their aggregate output during 1912 had a value of £15,000.

Coal.—In "Miscellaneous Reports," *Bulletin* No. 48, 1913, *Geological Survey of Western Australia*, E. S. Simpson gives the results of investigations into the composition and properties of coals from the Collie coal field. The Collie coal measures are stated by A. G. Maitland (*Bulletin* No. 50) to be of Permo-Carboniferous age. The samples examined are from seams worked at depths of from 100 to 250 feet, and the seams vary from 6 to 10 feet in thickness. The coals are described as non-caking coals of the hydrous bituminous class. Though belonging to the same general class, the coals are of two types. One of these, the "Proprietary" type, is dull and porous, dirty to handle, crumbles on exposure to the air, and burns freely without much smoke. The other, the "Collieburn" type, is bright and compact, clean to handle, burns less freely, and gives off an appreciable amount of smoke.

The mean proximate analyses of the two types of coal are as follows:

	Proprietary type.	Collieburn type.
	Per cent.	*Per cent.*
Fixed carbon	48·48	40·20
Volatile matter	24·79	32·17
Moisture	18·62	23·32
Ash	8·11	4·31
Calorific value (B.T.U.)	9,695	9,516
Specific gravity	1·39	1·32

A notable feature of these coals is the high percentage of water they contain, even when quite dry to the touch and free from visible "mine-water." The whole of this water is lost when the coal is powdered and heated to 100° C. for an hour; and about a third of it is given off in a few hours when the powdered coal is left exposed to the atmosphere.

Two samples of Collieburn coal, containing when fresh 22·43 per cent. and 23·72 per cent. of moisture respectively were crushed to pass a half-inch sieve and left exposed to the air. After thirty-one days the moisture percentages

were 14·95 and 9 respectively. The moisture percentage of a sample of Proprietary coal similarly treated dropped from 19·52 to 12·25. After exposure for a month the percentage of moisture remained constant.

Gold.—*Bulletin* No. 51, 1913, *Geological Survey of Western Australia*, is Part II of a series dealing with the geology and ore deposits of Kalgoorlie and gives an account of the East Coolgardie Gold Field. Outcrops are scarce in the area dealt with, and the work of mapping has been rendered difficult by the extensive decomposition of the rocks at the surface. The oldest rocks of the area are amphibolites and talc-chlorite rocks, which have resulted from the metamorphism of dolerites and other basic types. Of somewhat later age is a quartz keratophyre, which appears to be intimately related to some of the ore bodies, and which in two localities contains free gold. It is considered too early yet to formulate any theories as to the manner of formation of the Kalgoorlie ore deposits, and the original source of the gold they contain.

In *Bulletin* No. 54, 1914, *of the Geological Survey of Western Australia*, J. T. Jutson deals with the mining geology of Ora Banda, Broad Arrow Gold Field. This mining centre is of comparatively recent growth, its development dating only from 1907. Since that time, up to the close of 1912, Ora Banda has turned out 24,336 oz. of fine gold, from 76,433 tons of ore, *i.e.* 0·32 oz. per ton. The rocks occupying the area consist of an auriferous igneous complex; but owing to the cover of laterite and superficial deposits, they are visible at the surface in only a few places. Basic rocks are represented by gabbro, dolerite, porphyrite, epidiorite, and serpentine; acid rocks by granite and quartz porphyry. The porphyrite constitutes the matrix of those ore bodies, the oxidised zones of which have been responsible for the greater part of the Ora Banda gold output. The age of the Ora Banda series is uncertain, but it is believed to be pre-Cambrian.

Other recent publications issued by the Geological Survey of Western Australia dealing with the geology of gold-mining areas are: *Bulletin* No. 49, 1913, *Geology and Mineral Resources of the Yilgarn Gold Field*, Part I, Southern Cross; *Bulletin* No. 53, 1913, already referred to in connection with amblygonite on p. 497; and *Bulletin* No. 48, 1913, in which there are various miscellaneous reports.

Iron Ore.—The Mines Branch of the Canadian Department of Mines has issued a report on "Magnetite Occurrences along the Central Ontario Railway," by E. Lindeman (*Ottawa Govt. Printing Bureau*, 1913, No. 184). The area dealt with is occupied by Archæan rocks, including gneisses, schists, and crystalline limestones, with various intrusive masses of granite, syenite, diorite, and

gabbro. The iron-ore deposits of the district are of two types, viz. (1) magnetite occurring along or near the contact of limestone and schists with various igneous rocks; (2) titaniferous magnetites associated with gabbro intrusions.

The former or contact type occurs as steeply dipping lenses, and the magnetite is associated with pyroxene, amphibole, epidote, garnet, and calcite. The best quality of this type of ore averages about 54 per cent of metallic iron, but there would apparently be some difficulty in maintaining an output of ore at that standard; and a large proportion of the ore available does not contain more than 30 to 45 per cent. of metallic ore. Sulphur is high as a rule, owing to the presence of iron pyrites, and occasionally pyrrhotite. Phosphorus varies from 0·018 to 0·20 per cent.

The second type of deposit, consisting of segregations of titaniferous magnetite in gabbros, is too titaniferous to be of much value. Two occurrences that were examined gave samples containing 10 per cent. and 15·31 per cent. of titanium respectively. This fact, together with the irregularity and uncertain extent of the deposits, makes them of little or no economic importance.

Monazite.—According to E. S. Simpson (*Miscellaneous Reports, Bulletin* No. 48, 1913, *Geological Survey of Western Australia*), monazite occurs associated with cassiterite and columbite in the alluvial deposits at Cooglegong and Moolyella. A sample of 100 lb. from Cooglegong consisted of small pebbles weighing from 0·1 to over 10 grams. The Moolyella material so far obtained has been got by re-sluicing low-grade tin gravels, one of the products thus obtained being a high-grade tin ore, the other product containing, in one sample that was examined, 26·2 per cent. of monazite, 26·3 per cent. of cassiterite, 46·5 per cent. of columbite, and 1 per cent of garnet.

An analysis of picked monazite from these two localities showed the following composition:

		Cooglegong sp. gr. 5·3. *Per cent.*	Moolyella sp. gr. 5·26. *Per cent.*
Cerium oxide	Ce_2O_3	31·10	33·06
Lanthanum oxide	La_2O_3	34·26	30·21
Didymium oxide	Di_2O_3		
Yttrium oxide	Y_2O_3	0·04	0·14
Thoria	ThO_2	3·80	5·03
Ferric oxide	Fe_2O_3	0·42	2·21
Alumina	Al_2O_3	0·64	0·44
Lime	CaO	0·34	0·90
Magnesia	MgO	trace	0·21
Lead oxide	PbO	trace	trace
Phosphoric oxide	P_2O_5	26·89	26·70
Silica	SiO_2	1·96	1·22
Water	H_2O	0·58	0·59

The Moolyella mineral is darker and richer in thoria than the Cooglegong mineral, but so far as is known at present it occurs in smaller quantities.

Further search for alluvial deposits and pegmatite veins is recommended.

Radio-active Minerals.—Included in "Miscellaneous Reports," *Bulletin* No. 48, 1913, *Geological Survey of Western Australia*, is an account of the radio-active minerals occurring at Wodgina. The minerals referred to as occurring in notable quantities are hydrated silicates of uranium, thorium, and lead, and are described under the names of mackintoshite, thorogummite, and pilbarite. They occur as constituents of the "main tantalite lode" at Wodgina, near the western boundary of the Pilbara gold field. The predominant rocks of the area are "greenstone schists," and these are penetrated by numerous veins of pegmatite, one of which is the "main tantalite lode" containing tantalite, cassiterite, and the radio-active minerals already referred to. The portion of the pegmatite vein carrying the radio-active minerals has a width of about 30 ft. A cross cut at 70 ft. showed that the middle 15 ft. of the vein consisted of albite and quartz, and was devoid of metallic minerals. On either side of this was a band, 5 ft. or so in width, of coarse albite carrying a little quartz, dark mica, tantalite, and radio-active minerals, the band on the foot-wall side being stated to contain a larger quantity of tantalite and radio-active minerals than the band on the hanging wall side. Against the hanging wall were a few inches of a strongly foliated mixture of chlorite and biotite.

Practically the whole of the tantalite output of Wodgina has been obtained from the "main tantalite lode" or from the surface fragments weathered out of it.

The General Report of the Director of the Geological Survey of India for 1913 (*Rec. Geol. Surv. India*, 1914, **44**, Part I) includes a brief report by R. C. Burton on an occurrence of pitchblende at mica mines near Singar, Gaya district, Bengal. The pitchblende occurs as rounded nodules in a pegmatite that is intrusive in mica schists. Other minerals occurring in the pegmatite are mica, triplite, ilmenite, tourmaline, and uranium ochre; whitish columbite, zircon, and torbernite have also been recorded. Of these minerals triplite is stated to be the commonest. It is associated so persistently with the pitchblende and uranium ochre that its presence is taken as an indication of the presence of these minerals. Many of the pitchblende nodules occur in a matrix of triplite; some occur in a felspathic matrix. One nodule of pitchblende weighing 36 lb. has been obtained. The pegmatite has been mined for many years for mica. As yet, not much pitchblende has been

obtained; but one pit has yielded up to the present about 4 cwts. of the mineral.

Tin Ore.—In his *Annual Report* for the year 1913 (*Fed. Malay States Govt. Gaz.*, March 27, 1914), the Geologist of the Federated Malay States gives a brief account of the tin deposits of Gunong Bakau, a mountain (4,426 ft.) on the Selangor-Pahang Boundary about ten miles from Peretah. This mountain consists of granite which is traversed by two different types of stanniferous deposits. The older of these is a quartz-topaz rock, occurring in veins which reach a thickness of 15 ft. The younger is a topaz-aplite, occurring partly in the form of veins and partly in the form of masses, which cut both the granite and the veins of quartz-topaz rock. Although cassiterite occurs disseminated in both types, it does not occur abundantly enough in the aplite to make this of value as tin ore, except at one place. The quartz-topaz rock, on the other hand, is richer in cassiterite. It contains as much as 9 per cent. in some cases, and at one quarry where it has been opened up the rock contains about 1·75 per cent. of cassiterite. The quartz-topaz veins are found outcropping all round the mountain, and at one locality a drive has been made into the hill along one of these veins for a distance of 300 ft.

NOTICES OF RECENT LITERATURE

THE WILDS OF MAORILAND. By James Mackintosh Bell, M.A., Ph.D. Pp. xiii + 257, Med. 8vo. (London: Macmillan & Co., 1914.) Price 15*s.*; post free, United Kingdom 15*s.* 5*d.*, abroad 15*s.* 10*d.*

The author, who was formerly Director of the Geological Survey of New Zealand, describes his travels off the beaten track in the New Zealand "back country." Only a few enthusiastic travellers have yet wandered from the paths of civilisation into the Alpine valleys or scaled the snow-clad peaks which look down upon the plains of Canterbury and the forests of Westland, while the fiord region of the south-west of the South Island still remains almost a *terra incognita*. In a chapter headed "From Whangaroa to the North Cape" we have a description of the Auckland Peninsula. To its shores came some of the first white settlers in Maoriland during the early part of the last century. Another section of the book describes the author's rambles in "The Hauraki Goldfields." There is an interesting account of the volcanic area, followed by a chapter on the Urewera Country, which occupies the heart of the eastern peninsula of the North Island, and is the last stronghold of the Maori. The rest of the book is mainly devoted to a description of the Southern Alps

and the Great Douglas Glacier, concluding with a general sketch of the geography and climate of New Zealand. The book is illustrated by excellent photographs and coloured reproductions of characteristic scenery.

NEW ZEALAND: Its History, Commerce, and Industrial Resources. Compiled by Somerset Playne, F.R.G.S., assisted by J. W. Bond and H. H. F. Stockley, F.R.G.S. Edited by F. Holderness Gale. Pp. 699, Roy. 4to (London: Foreign and Colonial Compiling and Publishing Co., 1912-13). Price, 25*s.* net; post free United Kingdom, 25*s.* 9*d.*

This attractive volume is one of a series treating of outlying portions of the Empire, and it follows three books of similar style dealing respectively with British East Africa and Uganda, Cape Province, and the Orange Free State. Its general purpose is to give a complete literary and pictorial survey of the commercial, industrial, and agricultural resources of the territory dealt with, together with an account of the notable physical features of the country and also of its social side. The opening chapters describe the early history of the Dominion and the Maori race, and beside the topographical matter there are contributions by experts on the flora, climate and rainfall, geology, sport, and the dairying industry, which add considerably to the usefulness of the publication. There are over 2,000 photographs depicting New Zealand life in its many social and industrial activities as well as the beauties of the scenery.

LA GÉOGRAPHIE DE TERRE-NEUVE. By M. Robert Perret. With a preface by M. Marcel Dubois. Pp. vi + 372, Med. 8vo. (Paris: E. Guilmote, 1913.) Price 10 francs; post free, United Kingdom 8*s.* 5*d.*, abroad 9*s.*

Dr. Perret is to be congratulated on having produced a most comprehensive and scientific account of the geography of Newfoundland. As a proof of the painstaking and detailed manner in which he has dealt with the subject, it may be mentioned that the number of books and papers referred to amounts to no less than 406, in addition to a number of periodical publications and a large series of maps. As a result of his researches many gaps in our knowledge of the history of the island have been filled up. The opening chapter of the book deals with the history of exploration in the island, including an account of the visits of the earlier navigators, and is illustrated by reproductions of the maps of Sebastian Cabot (1544) and Pierre Bertius (1606). Subsequent chapters deal with the geology and physical features of the island, the oceanography of the Newfoundland Banks, the climate, the flora, and the fauna of land and sea. Two chapters are devoted to

the chief industries of the Colony; one deals with agriculture, the wood pulp industry and the mineral resources, and the other gives a detailed account of the sea-fisheries—by far the most important of the Newfoundland industries. The concluding chapters deal with the history of colonisation of the island, and its relations with the powers.

The book is well illustrated with maps and reproductions from photographs, but a regrettable feature is the absence of an index; the only indication of the subject matter is a contents list which consists merely of the titles of the chapters.

INDUSTRIAL AND COMMERCIAL GEOGRAPHY. By J. Russell Smith. Pp. xi + 914, Demy 8vo. (London: Constable & Co., Ltd., 1914.) Price 15*s.* net.; post free, United Kingdom 15*s.* 6*d.*, abroad 15*s.* 10*d.*

Prof. Russell Smith begins his preface to this book with the sentence, "This book aims to interpret the earth in terms of its usefulness to humanity." That statement usefully indicates the wide scope of his subject as conceived by the geographer of modern times, and proclaims the very important part which geography should take in present-day education of all grades.

The author divides his subject into two parts. The first of these deals in seventeen chapters with the nature and the regional distribution of the great industries of the world. As an example of his method, the chapter on "Condiments and Tobacco" may be referred to more particularly. This chapter deals with coffee, tea, cacao, spices, and tobacco. Each of these products is discussed in turn, the factors influencing the location of the particular crop, the preparation of the produce for the market; the chief features of its production in the principal areas and statistics of production and consumption, being the usual sections into which the discussion is divided. No exception need be taken to this arrangement, but the author goes into unnecessary detail and as a result makes mistakes on technical points. A few of these may be mentioned. Under Formosa (p. 300) it is stated that "the best tea in the world is grown by Chinese people in the island of Formosa." It is quite true that the finest qualities of tea produced in Formosa have a delicacy and aroma which distinguish them from all other teas, but that does not make Formosa tea the best in the world. On p. 296 the following statement occurs: "Little oil cells give the leaf [*i.e.* the tea leaf] its flavour, while the stimulating quality comes from a substance called theine, which is almost exactly the same as the caffeine of the coffee and the stimulating principle in cocoa or chocolate." The flavour of tea is not due to the oil cells, though it is *partly* due to their contents, and theine is not merely "almost exactly

the same as caffeine," but is caffeine, practically all the caffeine made being extracted from waste tea. Under "cacao" (p. 307) it is asserted that "when carefully fermented the seeds [*i.e.* cocoa beans] are twice as valuable as when carelessly done." That may have been the case at one time, but the fact that unfermented cocoa now fetches almost as good a price as fermented cocoa is one of the most serious difficulties in the way of effecting an improvement in the quality of cocoa produced in West Africa. A much more serious mistake, however, is the fact that there is no reference whatever to the Gold Coast Colony in the section of the book devoted to cocoa, although that Colony is now the largest producer of cocoa in the world, and the industry there presents features of special interest from the point of view of those interested in economic and industrial geography.

Under the heading "Spices" it is stated (p. 310) that "the best preserved ginger is exported from South America, West Africa, Bengal, Cochin China, and, to a small extent, from North Queensland." The use of the term "preserved" is a little unfortunate here, as "preserved" ginger usually means ginger preserved in syrup, a commodity obtained almost entirely from China. The author appears to use "preserved" as synonymous with "prepared"; but even in this sense the statement is inaccurate, since the best prepared ginger comes from Jamaica and the Cochin district of India (not Cochin China), that from West Africa being almost the worst on the market. Under the heading "Vanilla" it is asserted (p. 311) that "the manufacture of vanillin, a substitute produced from sugar by electrolysis, threatens this industry" [*i.e.* the vanilla industry]. Vanillin is not made from sugar, but from eugenol, the chief constituent of clove oil. The introduction of vanillin certainly seriously affected the vanilla industry, causing a great fall in the prices obtained for vanilla, but there is good reason to believe that in recent years the consumption of vanilla has not seriously declined, and it seems probable that for many purposes vanilla cannot be substituted by vanillin. The section on spices is incomplete, there being no reference to caraway seed, cardamoms, aniseed, and other products largely used in the liqueur industry. The title of this chapter, "Condiments and Tobacco," is misleading, since the stimulant foodstuffs, cocoa, coffee, and tea, can hardly be called condiments, though this term might perhaps be used to include the spices.

The second part of the book deals with commercial geography in sixteen chapters. The first chapter discusses the law of trade, the next ten the various ocean routes, and the remainder deal with special subjects, such as the influence of the Panama Canal on ocean transport, the development and work of the trade centres of the world,

the balance of trade, and lastly the influence of geographic factors on the commercial policy of nations. All these subjects are well and clearly discussed, and this part of the books seems to be fairly free from errors of technical detail, which, as already indicated, are somewhat conspicuous in some portions of the first part.

The book contains a large number of illustrations, maps, graphs, and statistical diagrams.

INDIAN COTTON. By Arno Schmidt, Secretary to the International Federation of Master Cotton Spinners' and Manufacturers' Associations. Report on his Third Visit to India, October 1913—February 1914. Pp. 260, Roy. 8vo. (Manchester, 1914.)

This work contains an account of investigations made by the author during three visits to India, which he made with a view to studying the cultivation of cotton in that country, and also records the conclusions he has drawn with reference to the improvement of Indian cotton and the extension of the area devoted to the crop.

This book is divided into four parts. The first consists of a series of notes on the geography of the country, its administration, the organisation of the Agricultural Departments, the agricultural conditions, irrigation, the caste system, village systems, and land revenue and tenure. In the second part an outline is given of the history of cotton growing in India, together with statistics of the crops and the methods of handling and marketing the produce. The third part, which constitutes the greater part of the book, gives a detailed account of the conditions of the industry, the methods of cultivation adopted, and the varieties of cotton grown in each of the Provinces; whilst the fourth part deals briefly with the principal Indian industries, and especially with that of cotton manufacture. In an appendix statistical tables are provided showing the area under cotton, and the yield and exports in the different Provinces during the years 1902–3 to 1911–12, together with a glossary of Indian words and other information.

The work is provided with maps and numerous illustrations, and forms a useful memoir on the cultivation, utilisation, and commerce of Indian cotton.

CULTURE ET EXPLOITATION DU CAOUTCHOUC AU BRÉSIL. By O. Labroy and V. Cayla. Pp. 235, Imper. 8vo. (Paris: Société Générale d'Impression, 1913.)

This work is divided into five parts. Part I deals with general considerations of the rubber industry in Brazil and other parts of the world; Part II is devoted to *Hevea brasiliensis*; while Parts III, IV, and V deal respectively with *Manihot* species, *Castilloa* and "Mangabeira" (*Hancornia speciosa*). As one would expect, prominence is given

to Hevea rubber, nearly half the space being allotted to this important subject. The book furnishes a most useful résumé of the knowledge of the above-mentioned sources of rubber in Brazil, and also deals briefly with the various aspects of the rubber-planting industry in the Middle East and elsewhere. In each case the nature of the tree, its cultivation, the collection of latex and preparation of rubber, etc., are discussed; but it is obvious that a subject of such scope can only be dealt with briefly in a book of this size. The authors have drawn largely on the information of previous workers, and a very large amount of information previously scattered now becomes readily available. The value of this work would have been greater if more frequent references to sources of information had been given. There are numerous illustrations, many of which are reproductions from photographs.

DATE GROWING IN THE OLD WORLD AND THE NEW. By Paul B. Popenoe, with a chapter on the food value of the date by Charles L. Bennett, M.D. Pp. xviii+316, Demy 8vo. (West India Gardens, Altadena, California, U.S.A., 1913.) Price $2 net; post free, United Kingdom 8*s.* 9*d.*, abroad 9*s.* 1*d.*

Careful experimental work on the cultivation of the date palm has been carried on for many years by the United States Department of Agriculture, and has led to such successful results that, during the last two or three years, commercial planting has been undertaken on a large and steadily increasing scale. The date palm is capable of withstanding a certain amount of frost, but it requires a long, dry, and hot season to enable the fruit to ripen satisfactorily. For this reason the cultivation in the United States is necessarily limited to a small territory in the "desert region" of Southern California and Arizona. In this area it has been found possible to reproduce the conditions under which the date palm grows in the oases of North Africa and Arabia. The Coachella and Imperial Valleys of California and some parts of Arizona have proved well adapted to date cultivation. It is stated that the American-grown date is superior to the Old World product in both size and flavour.

The author of the work under consideration has spent two years in studying the subject in the most famous date-growing regions of the Orient, and has also had considerable experience of the cultural methods adopted in the United States, and has therefore been able to collect a large amount of information. The book deals with every phase of date cultivation, including the propagation of the palm, irrigation, manuring, pollination, artificial ripening, harvesting, and packing the crop for the market. One chapter is devoted to the diseases and pests by which

the palm is liable to be attacked, and measures for controlling them are indicated. A description is given of ninety of the most important varieties of dates in the United States.

The book is written in an interesting manner, contains a number of excellent illustrations, and will doubtless be of great value to all date growers, and especially those of the United States.

FIELD CROP PRODUCTION. By George Livingston, Assistant Professor of Agronomy, Ohio State University. Pp. xix+424, Crown 8vo. (New York: The Macmillan Company, 1914.) Price 6*s.* net; post free, United Kingdom 6*s.* 5*d.*, abroad 6*s.* 9*d.*

In this book the author describes the standard cereal, legume, root, grass, clover, and fibre crops, and the way they are grown and harvested. This is done simply and clearly, avoiding the numerous tables of figures and discussions on the merits of different manurial treatments, which, although very valuable for more advanced students, make exhaustive treatises on agriculture heavy reading for beginners. As it is written in the United States, maize receives a good deal of attention. Some account is given of seed testing and of the insect and fungoid enemies of the crops.

There are numerous illustrations, and the author has been very successful in the choice of the information imparted and the way it is presented. The book is intended to serve as a general text-book of field crops in elementary courses, and as a supplementary text-book in other courses, for students with little or no elementary knowledge of the subject, and thus to supplement the instruction given by the lecturer.

FILTERS AND FILTER PRESSES FOR THE SEPARATION OF LIQUIDS AND SOLIDS. From the German of F. A. Bühler. With additional matter relating to the theory of filtration, and filtration in sugar factories and refineries by John Joseph Eastick, F.I.C., A.R.S.M. Pp. viii+184, Roy. 8vo. (London: Norman Rodger, 1914.) Price 12*s.* net; post free, United Kingdom 12*s.* 4*d.*, abroad 12*s.* 8*d.*

An enormous variety of appliances, apparatus, and machinery is employed in industry for the purpose of separating solids and liquids. In the volume under notice the most useful of these are classified and described. The first part of the work is devoted to the various classes of filters, and the second to the presses used for separating solids and liquids, whilst in the third part an account is given of the theory of filtration and its practical application in the sugar industry. Following this is a collection of abridged specifications of sundry filter-press

patents and a list of United Kingdom patents relating to filters and filtering apparatus. The matter is well arranged and fully illustrated, and the book should prove of great service in the numerous industries in which processes of filtration are employed.

THE FIXATION OF ATMOSPHERIC NITROGEN. By Joseph KNOX, D.Sc. (Chemical Monographs Series, No. 4). Pp. iv +112, Crown 8vo. (London: Gurney & Jackson, 1914.) Price 2*s.* net; post free, United Kingdom 2*s.* 3*d.*; abroad 2*s.* 4*d.*

Until comparatively recently almost the only sources of the nitrogen compounds required for the chemical industries and for artificial manures were the sodium nitrate deposits of Chili and the ammonia and ammonium compounds produced by the destructive distillation of coal. The Chilian deposits would soon be exhausted if the present rate of consumption should continue, and the products obtained from coal would not be nearly sufficient to supply the demands of the chemical industries and agriculture. Fortunately, however, there is an inexhaustible supply of nitrogen in the atmosphere, and during the last few years a great deal of work has been done on the conversion of this into technically important nitrogen compounds, especially nitrates and ammonium compounds.

The present monograph gives a useful account of the chief discoveries which have been made in this connection. The methods and processes employed are considered under three main headings: (1) fixation of atmospheric nitrogen as nitric and nitrous acids or their salts; (2) synthesis of ammonia and ammonium compounds from atmospheric nitrogen; and (3) conversion of atmospheric nitrogen into compounds which readily yield ammonia. Each chapter deals first with the chemical reactions involved, and subsequently with their technical application on the manufacturing scale. The value of the book is greatly enhanced by the numerous references to the original literature of the subject.

IGNEOUS ROCKS AND THEIR ORIGIN. By R. A. Daly. Pp. xxii+563, Med. 8vo. (London: Hill Publishing Company, 1914.) Price 17*s.* net; post free, United Kingdom 17*s.* 5*d.*, abroad 17*s.* 11*d.*

The scope of this book is well described by the author as follows: "The book is intended to summarise and correlate the facts known about igneous rocks, with special emphasis on their field relations. Knowledge of petrography and a moderate acquaintance with the physics and chemistry of rock-melts are assumed, but the treatment of the subject is essentially geological. The work is divided into three parts. The first of these (Chapters II to VII

inclusive) broadly considers the facts which need explanation in a philosophy of the igneous rocks. The second part (Chapters VIII to XIV inclusive) contains a general eclectic theory on the subject. The third (Chapters XV to XXII inclusive) outlines the results of applying the general theory to the facts so far determined."

Prof. Daly's attitude of mind towards igneous problems is strongly expressed in the introduction, in which he remarks: "What geology, like every other science, needs to-day is a frank recognition that imaginative thought is not dangerous to science, but is the life-blood of science. . . . Science is built on a long succession of mistakes. . . . Progress, indefinitely more rapid, will be possible when men of science have more generally lost the fear of making mistakes in using to the uttermost their powers of correlation and deduction. . . . Science is drowning in facts."

Opinions will differ as to the soundness of this doctrine. There can be no doubt that the petrology of igneous rocks offers fine scope for imaginative work; and in this book Prof. Daly has written in strict accordance with the doctrine he enunciates in the introduction. He draws pretty fully on imaginative thought, but he leaves the critical reader wondering whether, after all, such a liberal use of the imagination is not perhaps liable to be a little dangerous to science. It can, of course, be dangerous only to those who lack the knowledge and ability to distinguish facts from interpretations.

It is one of the drawbacks of igneous petrology that facts of a certain kind concerning it are multitudinous, whilst the definitely established theories are few—so much is this the case that cautiously written treatises on the subject are apt to be too stodgy. Prof. Daly has tried to avoid this by coupling the facts on to hypotheses which, though not yet definitely established, are very interesting. His views are stimulating to the critical reader, and his book is excellently adapted for the use of advanced students who know sufficient of the facts and prevailing conceptions of petrology to be able to appraise at their proper value some of the interpretations which the author sets forth.

The book is one that is well worthy of study by all serious students of petrology; it cannot fail to stimulate thought and research; and, indeed, no one who wishes to understand some of the most important hypotheses connected with the origin of igneous rocks can afford to leave the book unread.

MANUAL OF PETROGRAPHIC METHODS. By A. Johannsen. Pp. xxviii + 649, Med. 8vo. (London: The Hill Publishing Company, 1914.) Price 25*s.* net; post free, United Kingdom 25*s.* 6*d.*, abroad 26*s.* 1*d.*

This book deals comprehensively with physical methods in petrography from the standpoint of the laboratory worker. It represents a large amount of labour in the reading and abstracting of the numerous scientific papers that are referred to; and students of petrography owe a debt to the author for having made this extensive compilation from widely scattered sources.

Optical methods bearing on the use of the polarising microscope and its accessories naturally claim a preponderance of space. The treatment of the subject is rather more academical than practical. The reverse of this would have been preferable, seeing that the book appears to aim chiefly at being a laboratory guide. Some matters are dealt with at much greater length than is necessary. As an instance of this, the long account of different types of polarising microscopes may be mentioned. On the other hand, in dealing with the examination of opaque minerals, although the author admits its practical importance, he states that the book is too limited in scope to deal with these methods, and merely gives a list of papers. The student with a practical turn of mind will have some regret that the author did not choose to give an account of this part of the subject, even if in so doing he had found it necessary to save space in dealing with some items of less practical importance.

As regards other physical methods one notes defects in the account of magnetic separation. The author follows certain other writers in attributing to Fouqué the credit, which really belongs to Delesse, of introducing the electromagnet in the examination of rocks. Moreover, the type of pole-pieces described in this book has long been superseded. No reference is made to the electrostatic method of mineral separation, a method which at times proves very useful in the laboratory.

A chapter is given to microchemical reactions; but it seems strange to an English reader to see the familiar staining tests for distinguishing certain minerals described as tests for the "separation" of these minerals (pp. 565–8). There is also a chapter on the preparation of sections and another on petrographic collections. An appendix comprises the Greek alphabet, some mathematical formulæ and tables, and some useful recipes.

The book is likely to prove very useful for study and reference among students of petrography.

DAS AUFSUCHEN UND DIE UNTERSUCHUNG VON LAGERSTÄTTEN NUTZBARER MINERALIEN IN DEN TROPEN. By O. Mann. Pp. v + 92, Demy 8vo. (Hamburg: Fr. W. Thaden.) Price 2.80 marks; post free, United Kingdom and abroad 3*s.* 1*d.*

This little book is intended as a simple guide to pro-

specting, for the use of officers, merchants, and planters in the tropics. The author is the Government Geologist of Togoland, formerly of Kamerun. In the first thirty-four pages is given a simple account of the equipment required by the prospector, a brief account of the commoner types of rocks and ore deposits, and a short practical description of prospecting methods. The remainder of the book is devoted chiefly to a description of the commoner ores and other useful minerals, and there is an appendix dealing with mining law in German Protectorates.

The simplicity of treatment gives the book an attractive appearance from the standpoint of the untrained prospector. A closer examination shows, however, that the author has not made a thorough study of the subject. As examples of erroneous teaching the following extracts may be quoted:

"Meist ist der Monazit recht schwer in dem Sand zu erkennen. Sicher feststellen kann man ihn nur mit Hilfe eines Spektroskopes" (p. 70).

"Kalk- und Kupferuranglimmer, die grünliche, glänzende Tafeln bilden, haben keine praktische Bedeutung" (p. 72).

"Unter den verschiedenen Glimmerarten hat nur der Muskovit praktische Bedeutung" (p. 82).

In fact, the book is not only inaccurate in many of its details; it is also defective in scope. It leaves unmentioned many important useful minerals; it does not give sufficient information to enable minerals to be identified; and it says little or nothing about the distribution of useful minerals. Hence, attractive as the book is in some respects, it is not to be trusted as a guide, and will require considerable revision and enlargement before it can be recommended for use.

THE LONDON CHAMBER OF COMMERCE FROM 1881 TO 1914. By Charles E. Musgrave. Pp. viii + 93, 8vo. (London: Effingham Wilson, 1914.) Price 2*s.* 6*d.* net; post free, United Kingdom 2*s.* 10*d.*, abroad 2*s.* 11*d.*

In this little book the Secretary of the London Chamber of Commerce gives a most interesting account of the growth and activities of the Chamber since it was formed in October 1881. In the first complete year of its existence it had 1,386 members, and an income of £3,215, whilst in 1913 its membership was 5,265 and its income £29,079. During the thirty-three years of its existence the Chamber has taken a leading part in organising commercial education, promoting commercial arbitration and labour conciliation schemes, and in encouraging Imperial commerce, to mention only a few of its more striking activities. At the same time, especially by means of its numerous trade sections, it has been able to render great assistance to the large number of trades carried on in and around London.

The membership figures quoted above prove that the Chamber has already secured a large body of support from the commercial community in London. Mr. Musgrave's account of the work of the Chamber shows that this support is well deserved, and it is to be hoped that its publication will still further extend the interest shown by London merchants and manufacturers in the work of the Chamber.

HANDBOEK VOOR CULTUUR-EN HANDELSONDERNEMINGEN IN NEDERLANDSCH - INDIË, 1914. Pp. x + 1655, Med. 8vo. (Amsterdam: J. H. de Bussy, 1913.) Price 10 florins; post free, United Kingdom 17*s.* 2*d.*, abroad 18*s.* 1*d.*

This excellent handbook, which has now reached the twentieth year of publication, should prove of great value to all interested in the agricultural and mining industries of the Dutch East Indies. Particulars are given of all plantations in the islands, including in most cases their output for a number of years. Next follows a directory of business houses arranged under the names of the towns in which they are situated. A large section of the book is devoted to accounts of the various joint-stock, trading, plantation, mining, and other companies connected with the Dutch East Indies, as well as of local associations and societies. Various laws and regulations at present in force are given, including those relating to concessions, the exploitation of forests, coolie labour, the cultivation of various crops, the importation of cattle, and mining and prospecting. Particulars are also furnished as to certain taxes and duties, and amongst other useful information there is a list of tariffs and a detailed list of all imported and exported articles showing the standard prices on which port dues are assessed.

BOOKS RECEIVED

ANGLO-EGYPTIAN SUDAN HANDBOOK SERIES. 1. "The Bahr El Ghazal Province." Pp. 164. 2. "Kordofan and the Region to the West of the White Nile." Pp. 215. Compiled in the Intelligence Department, Sudan Government, Khartoum. (London: H.M. Stationery Office, 1911 and 1912.)

LAITE'S COMMERCIAL BLUE BOOK FOR SOUTH AFRICA, 1914. Compiled and edited by W. J. Laite. Pp. 591. (Cape Town: South African Publishers, Ltd., 1914.) Price 3*s.* 6*d.* net; post free, United Kingdom 3*s.* 11*d.*; abroad 4*s.* 3*d.*

RUTHERFORD'S PLANTERS' NOTE BOOK. 6th Ed. Pp. lxix + 478. (Colombo and London: Times of Ceylon Company, 1914.) Price 20*s.*; post free, United Kingdom 20*s.* 5*d.*, abroad 20*s.* 10*d.*

INDIAN FOREST INSECTS OF ECONOMIC IMPORTANCE. COLEOPTERA. By Edward Percy Stebbing. Pp. xvi + 648 + 64 plates. (London: Eyre & Spottiswoode, Ltd., 1914.) Price 15*s.*; post free, United Kingdom, 15*s.* 7*d.*

PRACTICAL TROPICAL SANITATION. By W. Alex. Muirhead. Pp. xv + 288. (London: John Murray, 1914.) Price 10*s.* 6*d.* net; post free, United Kingdom 10*s.* 10*d.*, abroad 11*s.* 2*d.*

PHILLIPS'S PAPER TRADE DIRECTORY OF THE WORLD, 1913–14. By S. Chas. Phillips. Pp. lxxx + 850. (London: S. C. Phillips & Co.) Price 15*s.* 6*d.*; post free, United Kingdom 16*s.*, abroad 16*s.* 8*d.*

MINING WORLD INDEX OF CURRENT LITERATURE. Vol. V, January–June 1914. By Geo. E. Sisley. Pp. xxix + 237. (Chicago: The Mining World Company, 1914.) Price 8*s.*; post free, United Kingdom 8*s.* 8*d.*, abroad 8*s.* 11*d.*

WHY WE ARE AT WAR. GREAT BRITAIN'S CASE. By Members of the Oxford Faculty of Modern History. Pp. 206. (Oxford: Clarendon Press, 1914.) Price 2*s.* net; post free, United Kingdom 2*s.* 4*d.*, abroad 2*s.* 5*d.*

INDIA AND THE WAR. By Sir Ernest J. Trevelyan. Pp. 11. (London: Oxford University Press, 1914.) Price 1*d.* net; post free, United Kingdom and abroad, 1½*d.*

THE WAR AND THE DOMINIONS. By H. E. Egerton. Pp. 23. (London: Oxford University Press, 1914.) Price 2*d.* net; post free, United Kingdom and abroad, 3*d.*